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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

ATTORNEY'S DOCKET NUMBER

45900-000728/US

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

10/089691
NEW

EXPRESS MAIL LABEL NO.

INTERNATIONAL APPLICATION NO.

PCT/DK00/00554

INTERNATIONAL FILING DATE

October 4, 2000

PRIORITY DATE CLAIMED

October 4, 1999

TITLE OF INVENTION

COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

APPLICANT(S) FOR DO/EO/US

André ERIKSEN and Per ADAMSEN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☒ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is transmitted herewith.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98-1449 and International Search Report (PCT/ISA/210) in German with () references.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
 - 1) Nine (9) sheets of Formal Drawings
 - 2) Article 34 Amended Specification and Claims

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PATENT
Docket No. 45900-000728/US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): André ERIKSEN and Per ADAMSEN
Application No: NEW
Filed: April 3, 2002
For: COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

April 3, 2002

Sir:

The following preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE CLAIMS

Please amend the claims as follows:

1. (Amended) A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit generating thermal energy when processing and said cooling system comprising a heat exchanger intended for being in thermal contact with the processing unit, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling unit comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulator for at least starting

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and stopping the compressor and where the compressor is a low voltage compressor with a voltage usage below the voltage of the public electrical power distribution network.

3. (Amended) A computer system according to claim 1, wherein the regulating means is capable of variable regulating the rotational speed and thereby the capacity of the compressor, preferably by regulating the speed infinitely, alternatively by regulating the speed stepwise.

5. (Amended) A computer system according to claim 1, wherein the processing unit is of a type comprising a base plate having leggings extending parallel outwards from the base member, said leggings being intended for extending through openings in a slot mounted on a motherboard of the computer system.

6. (Amended) A computer system according to claim 5, wherein the processing unit and the heat exchanger both are enclosed in an insulation material and that the insulation material is provided between at least the heat exchanger and the ambient environment, preferably also between the processing unit and the ambient environment.

7. (Amended) A computer system according to claim 6 wherein the processing unit and the heat exchanger both are enclosed in a box, that insulation material is provided between at least the heat exchanger and the inside of the box, preferably also between the processing unit and the inside of the box.

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8. (Amended) A computer system according to claim 7, wherein a heating element is in contact with the outside of the box, alternatively is in contact with the inside of the box, where the heating element consists of resistive wires, that the wires are in contact with the insulation, alternatively are in contact with the box, and that electrical power is supplied to the resistive wires for providing a heating of the wires and to the insulation, alternatively a heating of the inside or the outside of the box.

9. (Amended) A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having leggings extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit and where the force is applied by means of spring members.

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10. (Amended) A computer system according to claim 9, where the force is applied by means of spring members being attached between the heat exchanger and the socket.

11. (Amended) A computer system according to claim 9, wherein the processing unit is of a type comprising a base plate having leggings extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system.

12. (Amended) A computer system according to claim 9, where the heat exchanger is contained in a box and where the force is applied by means of spring members being attached between the box and the socket.

13. (Amended) A computer system according to claim 12, where the box is provided with a first opening intended for receiving the heat exchanger and a second opening intended for receiving the pipes to and from the heat exchanger, and where the first opening is directed towards the base plate and the socket and has an orifice having circumferential measures being approximately the same as, alternatively smaller than, external measures of the base plate and the socket.

14. (Amended) A computer system according to any of claim 12, where the box is biased towards the base plate by means of biasing members, where the biasing members is attached between the box and the socket onto which the base plate is mounted.

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15. (Amended) A computer system according to claim 13, where the biasing members consist of at least one first part attached to the box and at least one second part attached to the socket, and where opposing ends of the first part and the second part are intended for being biased towards each other by fastening means, preferably adjustable fastening means such as bolts and nuts.

16. (Amended) A computer system according to claim 15, where other spring members are provided in connection with the fastening means, and where biasing of the first part and the second part of the biasing means takes place via the other spring members so that a biasing force between the box and the base plate, and thereby between the heat exchanger and the processing unit, is limited by a spring force of the spring members.

17 (Amended) A computer system according to claim 9, and where the heat exchanger consists of metallic balls being in close proximate contact with each other, preferably being sintered together, and where passages are formed between the balls, and where said passages form passages for the cooling refrigerant to pass through the heat exchanger.

18. (Amended) A computer system according to claim 17, and where the heat exchanger has a circular cylindrical shape, and where an end surface of the cylinder is in abutting contact with a top surface of the processing unit.

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19. (Amended) A computer system according to claims 9, wherein only the heat exchanger is enclosed in an insulation material, and where the insulation material is provided between the heat exchanger and the ambient environment.

20. (Amended) A computer system according to claim 9, wherein only the heat exchanger is enclosed in a box, and where insulation material is provided between the heat exchanger and the inside of the box.

21. (Amended) A computer system according to claim 9, wherein a heating element is in contact with the leggings extending from a bottom surface of the base plate of the processing unit, alternatively is in contact with a top surface of the base plate, where the heating element consists of resistive wires, and that electrical power is supplied to the resistive wires for providing a heating of the leggings and alternatively also of the base plate.

22. (Amended) A computer system according to claim 9, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer.

23. (Amended) A computer system according to claim 9, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.

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24 (Amended) A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

25. (Amended) A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

26. (Amended) A computer system according to claim 9, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

27. (Amended) A computer system according to a claim 9, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be

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thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

28. (Amended) A computer system according to claim 9, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

29. (Amended) A computer system according to claim 9, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

30. (Amended) A computer system according to claim 9, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

Please add the following new claims

31. (New) A computer system according to claim 1, wherein the heat exchanger is made of copper and that the pipes is made of copper and that the pipes and the heat exchanger are mutually able of being disconnected.

32. (New) A computer system according to claim 9, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer.

33. (New) A computer system according to claim 9, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.

34. (New) A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

35. (New) A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

36. (New) A computer system according to claim 9, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

37. (New) A computer system according to a claim 9, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

38. (New) A computer system according to claim 9, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

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39. (New) A computer system according to claim 9, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

40. (New) A computer system according to claim 9, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

41. (New) A computer system according to claim 9 wherein the heat exchanger is made of copper and that the pipes is made of copper and that the pipes and the heat exchanger are mutually able of being disconnected.

REMARKS

Claims 1-41 are now present in this application, with new claims 31-41 being added by the present Preliminary Amendment. It should be noted that the amendments to original claims 1-30 of the present application are non-narrowing amendments, made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations. For example, amendments have been made to broaden the claims;

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remove multiple dependencies in the claims; and to place claims in a more recognizable U.S. form, including the use of the transitional phrase "comprising" as well as the phrase "wherein". Again, all amendments are non-narrowing and have been made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations.

CONCLUSION

Accordingly, in view of the above amendments and remarks, an early indication of the allowability of each of claims 1-41 in connection with the present application is earnestly solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John A. Castellano at the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any

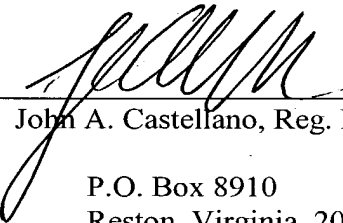
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additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly,
extension of time fees.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C

By:



John A. Castellano, Reg. No. 35,094

P.O. Box 8910
Reston, Virginia 20195
(703) 390-3030

JAC/cah

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Amended Claims With Mark-ups to Show Changes Made

1. (Amended) A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit generating thermal energy when processing and said cooling system comprising a heat exchanger intended for being in thermal contact with the processing unit [and where the processing unit is of a type comprising a base plate having leggings extending parallel outwards from the base member, said leggings being intended for extending through openings in a slot mounted on a motherboard of the computer system], and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling unit comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulator for at least starting and stopping the compressor and where the compressor is a low voltage compressor with a voltage usage below the voltage of the public electrical power distribution network.

3. (Amended) A computer system according to claim 1 [or claim 2], wherein the regulating means is capable of variable regulating the rotational speed and thereby the capacity of the compressor, preferably by regulating the speed infinitely, alternatively by regulating the speed stepwise.

5. (Amended) [A computer system according to any of the preceding claims, wherein the processing unit and the heat exchanger both are enclosed in an insulation material and that the

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insulation material is provided between at least the heat exchanger and the ambient environment, preferably also between the processing unit and the ambient environment] A computer system according to claim 1, wherein the processing unit is of a type comprising a base plate having leggings extending parallel outwards from the base member, said leggings being intended for extending through openings in a slot mounted on a motherboard of the computer system.

6. (Amended) [A computer system according to claim 5 wherein the processing unit and the heat exchanger both are enclosed in a box, that insulation material is provided between at least the heat exchanger and the inside of the box, preferably also between the processing unit and the inside of the box] A computer system according to claim 5, wherein the processing unit and the heat exchanger both are enclosed in an insulation material and that the insulation material is provided between at least the heat exchanger and the ambient environment, preferably also between the processing unit and the ambient environment.

7. (Amended) [A computer system according to any of the preceding claims, wherein a heating element is in contact with the outside of the box, alternatively is in contact with the inside of the box, where the heating element consists of resistive wires, that the wires are in contact with the insulation, alternatively are in contact with the box, and that electrical power is supplied to the resistive wires for providing a heating of the wires and to the insulation, alternatively a heating of the inside or the outside of the box] A computer system according to claim 6 wherein the processing unit and the heat exchanger both are enclosed in a box, that insulation material is provided between at least the heat exchanger and the inside of the box,

preferably also between the processing unit and the inside of the box.

8. (Amended) [A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having legging extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit] A computer system according to claim 7, wherein a heating element is in contact with the outside of the box, alternatively is in contact with the inside of the box, where the heating element consists of resistive wires, that the wires are in contact with the insulation, alternatively are in contact with the box, and that electrical power is supplied to the resistive wires for providing a heating of the wires and to the insulation, alternatively a heating of the inside or the outside of the box.

9. (Amended) [A computer system according to claim 8, where the force is applied by means of spring members being attached between the heat exchanger and the socket] A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having legging extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit and where the force is applied by means of spring members.

10. (Amended) [A computer system according to claim 8 or claim 9, where the heat exchanger is contained in a box and where the force is applied by means of spring members being attached between the box and the socket] A computer system according to claim 9, where the force is applied by means of spring members being attached between the heat exchanger and the socket.

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11. (Amended) [A computer system according to claim 10, where the box is provided with a first opening intended for receiving the heat exchanger and a second opening intended for receiving the pipes to and from the heat exchanger, and where the first opening is directed towards the base plate and the socket and has an orifice having circumferential measures being approximately the same as, alternatively smaller than, external measures of the base plate and the socket] A computer system according to claim 9, wherein the processing unit is of a type comprising a base plate having legging extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system.

12. (Amended) [A computer system according to any of claim 10 or claim 11, where the box is biased towards the base plate by means of biasing members, where the biasing members is attached between the box and the socket onto which the base plate is mounted] A computer system according to claim 9, where the heat exchanger is contained in a box and where the force is applied by means of spring members being attached between the box and the socket.

13. (Amended) [A computer system according to claim 12, where the biasing members consist of at least one first part attached to the box and at least one second part attached to the socket, and where opposing ends of the first part and the second part are intended for being biased towards each other by fastening means, preferably adjustable fastening means such as bolts and nuts] A computer system according to claim 12, where the box is provided with a first opening intended for receiving the heat exchanger and a second opening intended for receiving the pipes to and from the heat exchanger, and where the first opening is directed

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towards the base plate and the socket and has an orifice having circumferential measures being approximately the same as, alternatively smaller than, external measures of the base plate and the socket.

14. (Amended) [A computer system according to claim 13, where other spring members are provided in connection with the fastening means, and where biasing of the first part and the second part of the biasing means takes place via the other spring members so that a biasing force between the box and the base plate, and thereby between the heat exchanger and the processing unit, is limited by a spring force of the spring members]. A computer system according to any of claim 12, where the box is biased towards the base plate by means of biasing members, where the biasing members is attached between the box and the socket onto which the base plate is mounted.

15. (Amended) [A computer system according to any of claims 8-15, and where the heat exchanger consists of metallic balls being in close proximate contact with each other, preferably being sintered together, and where passages are formed between the balls, and where said passages form passages for the cooling refrigerant to pass trough the heat exchanger] A computer system according to claim 13, where the biasing members consist of at least one first part attached to the box and at least one second part attached to the socket, and where opposing ends of the first part and the second part are intended for being biased towards each other by fastening means, preferably adjustable fastening means such as bolts and nuts.

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16. (Amended) [A computer system according to claim 15, and where the heat exchanger has a circular cylindrical shape, and where an end surface of the cylinder is in abutting contact with a top surface of the processing unit] A computer system according to claim 15, where other spring members are provided in connection with the fastening means, and where biasing of the first part and the second part of the biasing means takes place via the other spring members so that a biasing force between the box and the base plate, and thereby between the heat exchanger and the processing unit, is limited by a spring force of the spring members.

17 (Amended) [A computer system according to any of claims 8-16, wherein only the heat exchanger is enclosed in an insulation material, and where the insulation material is provided between the heat exchanger and the ambient environment] A computer system according to claim 9, and where the heat exchanger consists of metallic balls being in close proximate contact with each other, preferably being sintered together, and where passages are formed between the balls, and where said passages form passages for the cooling refrigerant to pass through the heat exchanger.

18. (Amended) [A computer system according to any of claims 8-17, wherein only the heat exchanger is enclosed in a box, and where insulation material is provided between the heat exchanger and the inside of the box] A computer system according to claim 17, and where the heat exchanger has a circular cylindrical shape, and where an end surface of the cylinder is in abutting contact with a top surface of the processing unit.

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19. (Amended) [A computer system according to any of claims 8-18, wherein a heating element is in contact with the leggings extending from a bottom surface of the base plate of the processing unit, alternatively is in contact with a top surface of the base plate, where the heating element consists of resistive wires, and that electrical power is supplied to the resistive wires for providing a heating of the leggings and alternatively also of the base plate] A computer system according to claims 9, wherein only the heat exchanger is enclosed in an insulation material, and where the insulation material is provided between the heat exchanger and the ambient environment.

20. (Amended) [A computer system according to any of the preceding claims, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer] A computer system according to claim 9, wherein only the heat exchanger is enclosed in a box, and where insulation material is provided between the heat exchanger and the inside of the box.

21. (Amended) [A computer system according to any of the preceding claims, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components] A computer system according to claim 9, wherein a heating element is in contact with the leggings extending from a bottom surface of the base plate of the processing unit, alternatively is in contact with a top surface of the base plate, where the

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heating element consists of resistive wires, and that electrical power is supplied to the resistive wires for providing a heating of the leggings and alternatively also of the base plate.

22. (Amended) [A computer system according to any of the preceding claims, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet] A computer system according to claim 9, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer.

23. (Amended) [A computer system according to any of claims 1-18, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet] A computer system according to claim 9, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.

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24. (Amended) [A computer system according to any of the preceding claims, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials] A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

25. (Amended) [A computer system according to any of the preceding claims, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger] A computer system according to claim 9, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

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26. (Amended) [A computer system according to any of the preceding claims, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment] A computer system according to claim 9, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

27. (Amended) [A computer system according to any of the preceding claims, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture] A computer system according to a claim 9, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

28. (Amended) [A computer system according to any of the preceding claims, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the

first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe] A computer system according to claim 9, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

29. (Amended) [A computer system according to any of the preceding claims wherein the heat exchanger is made of copper and that the pipes is made of copper and that the pipes and the heat exchanger are mutually able of being disconnected] A computer system according to claim 9, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

30. (Amended) [A cooling system for a computer system, said computer system comprising a number of electronic components generating thermal energy when being employed and said cooling system constituting a separate cooling system with a fan for sucking air from the surroundings into the cooling system, and a heat exchanger for cooling the air being sucked into the cooling system, and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and further on to the condenser, and said cooling system further comprising a means for passing air, that has been sucked past the heat exchanger and thereby has been cooled by the cooling system, to the interior of a

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cabinet of a computer system] A computer system according to claim 9, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.



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PATENT
Docket No. 45900-000728/US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): André ERIKSEN and Per ADAMSEN
Application No: 10/089,691
Filed: April 3, 2002
For: COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

SUPPLEMENTAL PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

April 23, 2002

Sir:

The following supplemental preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE CLAIMS

Please amend the claims as follows:

9. (Twice Amended) A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes

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leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit and where the force is applied by means of spring members.

22. (Twice Amended) A computer system according to claim 1, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer.

23. (Twice Amended) A computer system according to claim 1, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.

24. (Twice Amended) A computer system according to claim 1, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

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25. (Twice Amended) A computer system according to claim 1, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

26. (Twice Amended) A computer system according to claim 1, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

27. (Twice Amended) A computer system according to a claim 1, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

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28. (Twice Amended) A computer system according to claim 1, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

29. (Twice Amended) A computer system according to claim 1, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

30. (Twice Amended) A computer system according to claim 1, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

Please add the following new claim

42. (New) A cooling system for a computer system, said computer system comprising a number of electronic components generating thermal energy when being employed and said cooling system constituting a separate cooling system with a fan for sucking air from the surroundings

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into the cooling system, and a heat exchanger for cooling the air being sucked into the cooling system, and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and further on to the condenser, and said cooling system further comprising a means for passing air, that has been sucked past the heat exchanger and thereby has been cooled by the cooling system, to the interior of a cabinet of a computer system.

REMARKS

Claims 1-42 are now present in this application, with new claim 42 being added by the present Supplemental Preliminary Amendment. It should be noted that the amendments to original claims 9 and 22-30 of the present application are non-narrowing amendments, made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations. For example, amendments have been made to broaden the claims; remove multiple dependencies in the claims; and to place claims in a more recognizable U.S. form, including the use of the transitional phrase "comprising" as well as the phrase "wherein". Again, all amendments are non-narrowing and have been made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations.

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CONCLUSION

Accordingly, in view of the above amendments and remarks, an early indication of the allowability of each of claims 1-42 in connection with the present application is earnestly solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John A. Castellano at the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C.

By: 

John A. Castellano, Reg. No. 35,094

P.O. Box 8910
Reston, Virginia 20195
(703) 390-3030

JAC/cah

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Amended Claims With Mark-ups to Show Changes Made

9. (Twice Amended) A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit [and where the processing unit is of a type comprising a base plate having leggings extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system], and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit and where the force is applied by means of spring members.

22. (Twice Amended) A computer system according to claim [9] 1, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer.

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23. (Twice Amended) A computer system according to claim [9] 1, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.

24. (Twice Amended) A computer system according to claim [9] 1, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

25. (Twice Amended) A computer system according to claim [9] 1, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

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26. (Twice Amended) A computer system according to claim [9] 1, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

27. (Twice Amended) A computer system according to a claim [9] 1, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

28. (Twice Amended) A computer system according to claim [9] 1, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

29. (Twice Amended) A computer system according to claim [9] 1, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

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30. (Twice Amended) A computer system according to claim [9] 1, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

Claim 42 has been added.

COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

BACKGROUND OF THE INVENTION

- 5 The present invention relates to a computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said computer system also comprising a cooling system with a heat exchanger being in thermal contact with the CPU and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting
- 10 the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulating means for at least starting and stopping the compressor.
- 15 It is known to cool the processor of a computer system in order to increase the operating frequency of the processor to a value above the value intended or expected by the producer of the processor. Whenever a processing unit of a computer system is processing, heat is generated. This reduces the working capacity of the unit, and therefore it is desirable to cool the processing unit by means of a cooling system in order
- 20 to increase the processing frequency of the processor.

DESCRIPTION OF THE PRIOR ART

- US 5.574.627 describes such a cooling system. The system comprises a heat exchanger
- 25 being in contact with a central processing unit. The CPU is attached to a so-called motherboard. A refrigeration compressor unit such as the one used in a conventional refrigerator provides the cooling. Similar cooling unit is further described at homepage www.kryotech.com from the company Kryotech, Inc. Around the CPU and around the heat exchanger, insulation is provided. The insulation ensures that any dew that may be
- 30 generated on the cool surface of the heat exchanger or on the cooled down surface of the processor is avoided. However, if dew never the less should generate on the insulation, resistive ink is provided at the outer surface of the insulation in order to heat the insulation if necessary.

This cooling system described in this patent and also the system described at the web-site www.kryotech.com have some disadvantages. Firstly, the compressor used is very bulky compared to the rest of the components of the computer system which all should be as small as possible for fulfilling the demands of small sized computers. The compressor
5 is a conventional compressor using high voltage power supply such as 220/230 V or 110/115 V. This creates the need for extra electrical insulation and other measures for maintaining a sufficient electrical security. Also, the heat generated by the compressor will to a certain extend be conducted up through the computer itself and past the components of the computer system thereby increasing the internal temperature of the casing of the
10 compressor.

US 5.488.279 describes using a low-voltage compressor to be used in an electrical refrigerator working at locations away from an access to the public electrical network such as off a battery incorporated in an automobile. Thus, using a low-voltage compressor in a
15 refrigerator in an automobile is due to the necessity of using a compressor, which is capable of running on electrical power having a voltage level corresponding to the voltage level that an automobile can provide. There is no discussion of the possible advantages of using a low voltage compressor in stead of using a high voltage compressor, namely because using a low voltage compressor is a necessity and not an option when using it in
20 an electrical refrigerator in an automobile.

US 6.054.676 describes an apparatus for cooling an integrated circuit. The cooling unit comprises casings enclosing a base plate that the integrated circuit is mounted to. Inside the casing a cold plate is provided. The cold plate is situated, together with the integrated
25 circuit, within the casing, and the casing provides insulation around the cold plate. The apparatus also comprises a heating foil being provided with holes along the periphery of the foil. Leggings extending from the base plate extend through the holes in the heating foil. The cooling of the integrated circuit and the heat exchanger is dependant on the insulating capacity of the casing, and the thermal contact between the cold plate and the
30 integrated circuit is limited because there is no means for establishing a close physical contact between the cold plate and the integrated circuit.

US 5,539,155 describes an apparatus for cooling an integrated circuit chip. The apparatus comprises a cooling pipe being in contact with a pad, said pad being in contact with a
35 surface of the circuit chip. The cooling pipe is maintained to the pad by means of a

number of clips and the pad is kept in place on top of the surface of the circuit chip by means of holding fixture with a hole through which the pad extends. The holding fixture is secured to the motherboard by means of screws at each side of the circuit chip. This apparatus has the disadvantage that a substantial temperature gradient exists between
5 the cooling pipe and the pad, thus limiting the cooling of the pad. Furthermore, the pad is kept in place by means of a holding fixture taking up a lot of space. Such space is seldom available on a motherboard. If the space is made available, such space severely limits the possibility of decreasing the space taken up by the electronic components in common. Finally, it may be very difficult to gain access with a screwdriver for securing the holding
10 fixture to the motherboard.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a computer system with a cooling system
15 where the flexibility of using the cooling system is greater than for known systems and where the risk of electrical damage or lack of electrical security is reduced so that the overall functionality of the computer system is increased.

This purpose is obtained by a computer system where the compressor is a low voltage
20 compressor with a voltage usage below the voltage of the public electrical power distribution network.

Using the public net is obvious because the computer system itself always has the need for electrical power from the public net, so there is no reason why the compressor should
25 not also have electrical power from the public net. However, by using a low voltage compressor certain surprising advantages are obtained compared to using conventional high voltage compressors adapted for using the voltage supply of the public electrical distribution net, although special supplementary features are needed in the computer system, which may cause disadvantages which do not occur when using high voltage
30 compressors. However, the advantages obtained when using low voltage compressor may justify the disadvantages involved.

A first advantage of using a low voltage compressor is that it is possible to power the compressor from the electrical power supply of the computer system itself, thereby
35 eliminating the need for a supplementary power supply. It also means that using the

computer with different networks as example 220/230 V or 110/115 V is indifferent to the compressor because the power is supplied from the power supply of the computer system. Any switch between as example 220 V and 110 V will just have to be made for the components of the computer, and the compressor neither needs to be suited for the
5 actual voltage of the electrical distribution network nor needs to have a switch of its own for switching between different voltages of networks around the world.

A second advantage of using a low voltage computer is that it is very easy to incorporate means for regulating the capacity of the compressor. This makes it possible to individually
10 graduate the degree of lowering the temperature and also makes it possible to adjust the capacity in response to the need for cooling. As example, when the computer system is in a standby mode or in any other way is not performing greater processing, then the need for cooling is limited as compared to situations when the processor is performing actual processing. The means for regulating the capacity of the compressor may be controlled
15 by additional software incorporated in the computer system. The means for regulation may also be more conventional regulating means or a combination of these and software controlling.

A third advantage is that the size of a low voltage compressor may be smaller than the
20 size of a conventional high voltage compressor. This means that the space needed for the cooling system is limited and advantageously the cooling system may be incorporated into the standard cabinet of the computer system. Also, the power consumption of a low voltage compressor is lower than that of conventional high voltage compressors, as example 50W compared to 120W. Apart from reducing the overall power consumption of
25 the computer system, the reduced power consumption may also limit the size of certain electrical components in the compressor.

Also it is possible to incorporate the compressor into the top of the cabinet because not only the size but also the weight of the low voltage compressor may be smaller than for
30 conventional compressors. Accordingly, there will neither be any space problem nor any stability problem of placing the compressor in the top of the cabinet. Placing the compressor in the top of the cabinet means that the heat generated when the compressor is working is not passed through the computer itself and is not passed through the components of the computer system.

In a preferred embodiment the computer system wherein the CPU and the heat exchanger are enclosed in a box, the insulation material is provided between at least the heat exchanger and the inside of the box, preferably is provided also between the CPU and the inside of the box.

5

The advantages of enclosing the heat exchanger and the processor in insulation are already known. However, also enclosing the insulation in a box has the advantage that the processor and the insulation are capsuled and constitute a unit of its own. Enclosing the heat exchanger and the processor together with the insulation in a box means that it is actually possible to market and sell these components as an integrated unit.

As example, if a computer already having a cooling system has to be upgraded, then it is necessary to substitute the processor. Substituting the processor may involve also substituting the heat exchanger to one with a larger cooling capacity. This can easily be done if the processor, the heat exchanger and the insulation are enclosed in a box constituting a unit. Thereby it is not necessary to dismantle the insulation and the heat exchanger, substituting the processor and afterwards assemble the heat exchanger and the insulation again.

If the box is black and perhaps is also lustreless, then the outside of the box will have the best opportunity to receive heat from the surroundings, and thereby keeping as high a temperature as possible of the box. This avoids the formation of dew on the box. The box may as a supplement be provided with a heating element in thermal contact with the outer or inner surface of the box for heating the box to further avoid the formation of dew.

However, in other situations it may only be necessary to substitute the processor, but not absolutely necessary to substitute the heat exchanger. Also in this situation it is convenient to have the processor, the heat exchanger and the insulation all enclosed in a box. It will be possible to dismantle the insulation and the heat exchanger outside of the computer system and thereafter substituting the processor and assemble the insulation and the heat exchanger again also outside the computer and finally placing the box in the computer.

Thus the overall flexibility of the computer system according to the invention is highly increased by the combination of the above mentioned features. This is important in especially this field of business, where the technical development is extremely fast and

therefore fosters the need of a possibility to substitute one or more components with new components, but also a need for a uniform product that may be used all around the world because most computer systems are universal. Thus using a low voltage compressor makes the computer system according to the invention universal, while using components
5 that are not physically bonded together and which are enclosed in a box constituting a unit at the same time increases the flexibility by facilitating easy substitution of the components.

Another aspect of the present invention is to further increase the cooling of the computer
10 system by means of an exterior cooling system functioning as an air conditioning system for cooling the interior of a computer cabinet. A separate cooling system from which a hose or a pipe leads to the cabinet of a computer system and through which hose or pipe pre-cooled air is let into the computer cabinet has the effect of cooling the entire interior of the cabinet, i.e. the air and thus all components inside the cabinet. The processing units
15 are those that are most relevant to cool and depending on the type of processing unit and the way it is attached to the motherboard the firstly mentioned or the alternative mentioned type of heat exchanger may be employed.

However, a further advantage by cooling can be obtained by also cooling the interior of
20 the computer cabinet. By only cooling the interior of the computer cabinet and not also cooling the exterior surroundings of the cabinet, a much faster and more efficient cooling takes place and it is possible to obtain a certain cooling rate by means of only a smaller cooling system. Lastly, it is possible to take the cooling system along to the computer to be cooled, thus not being restricted to cooling the computers being situated in a certain
25 room being provided with air condition for the entire room, i.e. where also the exterior surroundings of the computer cabinets being cooled in such a room.

BRIEF DESCRIPTION OF THE INVENTION

30

The invention will now be described in detail with reference to the accompanying drawing, where

fig. 1 shows an embodiment of a computer system with a cooling system according to the
35 invention with a cooling unit enclosed in a box that is mounted in the computer system,

- fig. 2 shows a cooling system mounted in the top of a computer cabinet and comprising a compressor and an external heat exchanger,
- fig. 3 shows the box with the embodiment of the invention enclosed and provided with a heating element around the exterior of the box,
- 5 fig. 4 shows different components of the box enclosing part of the cooling system according to the invention
- fig. 5 - fig. 13 show different steps in assembling the components inside the box and in assembling the box itself,
- fig. 14 shows an alternative embodiment of the invention enclosed in a box that is
- 10 alternatively mounted in a computer system,
- fig. 14a shows a cross section of an embodiment of a heat exchanger to be used in the alternatively mounted box, and
- fig. 15 and fig. 16 shows an embodiment of a separate cooling system for cooling the interior of a computer cabinet.

15

DETAILED DESCRIPTION OF THE INVENTION

- Fig. 1 is a photograph showing a motherboard 1 inside a computer cabinet 2. At the
- 20 motherboard 1 a black box 3 is shown. The box 3 encloses the central processing unit (CPU) (not shown) of the computer system. Apart from enclosing the CPU, the box also encloses a cooling unit comprising a heat exchanger (not shown) being in thermal contact with the CPU. The box is kept in place by means of the connection pins from the printed circuit board at which the CPU is placed (see fig. 6), said connection pins being inserted
- 25 in the appropriate slots in the motherboard. A hose 4 extends from the box 3 to a compressor (see fig. 2). The hose 4 contains metal piping for conducting coolant liquid from the compressor to the heat exchanger in the box and for returning the vaporised coolant from the heat exchanger in the box to the compressor.
- 30 Fig. 2 is a photograph showing the part of the cooling system being outside the box (see fig. 1), i.e. all of the cooling system, except the parts inside the box including the heat exchanger being in thermal contact with the CPU. The cooling system comprises a compressor 5. The compressor 5 is a special low voltage compressor, preferably a 12V compressor. A metal piping (not shown) is leading through the hose 4 from the
- 35 compressor 5 to the heat exchanger in the box (see fig. 1), and an other metal piping 6 is

leading back to the compressor 5. Before being led to the heat exchanger being in thermal contact with the CPU, the vaporised coolant is led past an exterior condenser 7 for liquefying the coolant.

- 5 The cooling system is placed inside the standard cabinet 2 of a computer system, and is placed in the top of the cabinet. This way it is assured that the heat from the compressor 5 when in duty and the heat from the exterior heat exchanger 7 shown is not led past any of the other components in the computer system causing these to be further heated. The duty periods of the compressor are regulated in accordance with the demand for cooling.
- 10 The regulation may be either an on/off switching of the compressor, or may be a stepwise or may even be an infinitely adjusting of the rotational speed of the compressor. Regulation of the rotational speed may be controlled by software programs installed in the computer system. Alternatively the regulation of the rotational speed may be controlled by hardware.

15

- In the embodiment of the cooling system as shown in fig. 1 and fig. 2, the compressor and the condenser is mounted on a frame. The frame has dimensions being the same as or smaller than inner dimensions of the computer cabinet. Preferably the frame and the compressor and condenser has a width being not larger than 5 1/4" (five and a quarter of
- 20 an inch) or alternatively a width being not larger than 3 1/2" (three and a half of an inch). Thereby it is possible to use one or more of the external so-called drive bay shafts, which are already fitted at the front side of the computer cabinet and which are externally accessible. Thereby, it is not necessary to dismount the entire cabinet of the computer cabinet in order to install or remove the cooling system from the interior of the computer
- 25 cabinet. The rails that may be mounted inside the computer cabinet for supporting a disc drive or other hardware facilities of the computer may in stead be used to support the frame of the compressor and the condenser.

- Fig. 3 is a photograph showing the box 3 provided with a heating element 8 around the
- 30 outer surface of the box. The heating element 8 consists of a foil 9 provided with metallic wires 10 attached to the foil. Electric wires 11 lead to the heating element 8 for providing electrical power to the wires 10 on the foil 9 in order to heat the outer surface of the box 3. By heating the outer surface of the box the risk of dew forming on the outer surface is avoided. Dew may occur because of the cold heat exchanger inside the box although
- 35 insulation is provided between the heat exchanger and the casing of the box.

Apart from being provided with a heating element 8 the box is preferably black and provided with a lustreless surface. Both of these features further minimises the risk of dew occurring because the casing of the box, when being black and lustreless, receives as much heat in the form of radiation heat both from the heating element wrapped around the outer surface of the box but also from the surroundings. Alternatively, the box may have other appearances in relation to colour and surface if the problem of dew occurring is not that great a problem. As example, if it is a greater problem that heat from the surroundings limits the capacity of the heating element inside the box because of heat penetrating through the box and through the insulation, it will be more favourable to have a white box with a shiny surface in order to reject as much of the heating radiating from the surroundings inside the computer system.

Fig. 4 is a photograph showing the different components of a cooling unit in a box shown in fig. 1 and fig. 3. The box 3 consists of a casing consisting of two halves 12,13 (see fig. 5 and fig. 13) and of insulation 14-17 for being placed inside the casing and for surrounding the CPU and the heat exchanger thereby forming a thermal barrier between these components and the casing of the box. Furthermore the box comprises bolts 18,19 and nuts 20 for holding together of the two parts which constitutes the casing (see the subsequent figures). The box also comprises a plate 21 for holding the heat exchanger in a firm physical and thereby firm thermal contact with the CPU. Lastly, as an option, the box comprises the heating element 8 in the form of the foil with wires (see fig. 3) for wrapping around the outer surface of the casing.

Fig. 5 - fig. 13 are photographs showing assembling of the box and of the CPU and the heat exchanger inside the box. Fig. 5 shows a first half part 12 of the casing into which a first layer 14 of insulation is placed. In the right side upper side 22 of the casing an opening 23 is provided for insertion of the tube 4 and the piping into the box 3. The part 12 of the casing and the insulation 14 are provided with holes 24 for accommodating the insertion of the bolts 19 through the insulation 14 and through the box 3. In the bottom 25 of the casing a slot (not shown) is provided through which the connecting pins of the print circuit board can be introduced (see fig. 7).

Fig. 6 shows a print circuit board 26 on which a central processing unit (CPU) 27 is placed. Also other electrical components are placed on the board 26. The board 26 is

provided with connection pins 28 along the lower edge of the board. The pins 28 are intended for insertion into corresponding slots in the motherboard (see fig. 1) of the computer system. Bolts 18 are attached to the print circuit board 26. The bolts 18 are for fastening of the plate 21 for keeping the heat exchanger in place in relation to the insulation and the casing of the box (see fig. 11). The board 26 is also provided with holes 29 for accommodating the insertion of the bolts 19 through the board.

Fig. 7 shows the print board circuit 26 as shown in fig. 6 placed in the half part 12 of the casing as shown in fig. 5. The connecting pins 28 on the print circuit board 26 are inserted through the slot (not shown) in lower part 25 of the part 12 of the casing so that the pins 28 extrude outside of the casing. Thereby the box may be fixed to the motherboard of the computer system by just inserting the connecting pins of the print circuit board in the corresponding slots in the motherboard (see fig. 1).

Fig. 8 shows a first intermediate layer 15 of insulation placed on top of the print circuit board 26 (see fig. 7). A rectangular opening 30 is made in the first intermediate layer 15 of insulation so that the CPU 28 is still exposed. The first intermediate layer 15 of insulation is provided with four holes (not shown) in the sides of the insulation through which the guiding bolts 18 and the bolts 19 for assembling the casing are extending.

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Fig. 9 shows a second intermediate layer 16 of insulation placed above the first intermediate layer 15 shown in fig. 8. The second intermediate layer 16 is provided with a rectangular opening 31 that is bigger than the opening 30 in the first intermediate layer 15 and intended for receiving the heat exchanger (see fig. 10). The second intermediate layer 16 is provided with a groove 32 extending from the opening 31 to the one side of the layer. The groove 32 is intended for receiving piping (see fig. 10) leading to and from the heat exchanger (see fig. 10). Also, the second intermediate layer 16 of insulation is provided with four holes (not shown) in the sides of the insulation through which the fastening bolts 18 and the assembling bolts 19 for assembling the casing are extending.

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Fig. 10 shows a heat exchanger 33 placed in the insulation in the casing. The heat exchanger 33 consists of a square block inside which canals (not shown) are made for the coolant to flow through the heat exchanger. The heat exchanger 33 is accommodated in the opening 31 of the second intermediate layer 16 of insulation (see fig. 9). Piping 34 leads the coolant to and from the heat exchanger 33. The piping 34 consists of an outer

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pipe with a larger diameter and an inner pipe with a smaller diameter. The inner pipe extends co-axially and inside the outer pipe. The tube 4 surrounding the piping 34 is shown outside the casing. The tube 4 is insulated so that the piping 34 leading between the heat exchanger 33 and the compressor 5 (see fig. 2) is thermally insulated from the 5 surroundings.

Fig. 11 shows the plate 21 for keeping the heat exchanger 33 in place. The plate 21 is provided with holes (not shown) through which the fastening bolts 18 and assembling bolts 19 are extending. Nuts 20 are screwed onto the bolts 18,19 so that the plate 21 is 10 kept in place against the heat exchanger 33 thereby assuring sufficient physical and thermal contact between the heat exchanger 33 and the CPU 27. Both the fastening bolts 18 and the assembling bolts 19 and the nuts 20 are made of plastic having a poor thermal conductivity. Thereby the bolts 18,19 and the nuts 20 will not be responsible of thermal transportation of energy either heat from the surroundings to the metal plate 21 and 15 further on to the heat exchanger 33 or cold from the heat exchanger 33 and further on to the metal plate 21 and to the surroundings.

Fig. 12 shows a final layer 17 of insulation placed above the already mounted components in the box. The final layer is provided with two holes (not shown) through 20 which the assembling bolts 19 extend.

Fig. 13 shows a second half part 13 of the casing of the box placed above all of the components inside the box and thereby enclosing these components in the box. The second half 13 of the casing is provided with two holes (not shown) through which the 25 assembling bolts 19 extend. Nuts 20 are screwed onto the bolts 19 for assembling the two halves 12,13 of the box. The box is now closed. The piping (not shown) extend out through the hole 23 (see fig. 5) in the upper right side of the box and is being provided with the tube 4 around it. The connecting pins 28 of the print circuit board 26 (see fig. 6) extend through the slot (not shown) in the bottom of the box.

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In the embodiment shown of the computer system according to the invention different alterations may be induced without departing from the scope of protection. As mentioned, it will be possible to exclude using the heating element wrapped around the box as shown in fig. 3. It will also be possible to use low voltage compressors with other voltage needs 35 than 12V, as example 6V, 24V or 48V. Also, in stead of using electrical power from the

built in power supply of the computer system it will be possible to provide a separate low voltage power supply for the compressor parallel to the built in power supply. Regulation of the rotational speed of the compressor may be adjusted between a simple on/off switching of the compressor to a constant 24-hour rotation of the compressor and
5 regulating the rotational speed according to the demand for cooling.

Fig. 14 is an exploded view of an alternative embodiment of a cooling unit for a computer system. As is the case with the before-mentioned cooling unit, the alternative embodiment also comprises a box 13, a heat exchanger 33, and insulation 16 provided around the
10 heat exchanger. Also, the box is constituted of two parts being held together by appropriate fastening means such as bolts 19 and nuts 20 as shown and similar to those keeping the two parts of the before-mentioned box together. The advantage of having the box constituted by two halves is that it is easy to join the two halves when the heat exchanger of the cooling unit is already placed in abutment with the processing unit that is
15 to be cooled. Thus, it is not necessary to have the complete casing joined and attached to the processing unit before installing the processing unit onto the motherboard.

The difference between the box of the before-mentioned cooling unit and the box of the alternative embodiment is determined by a difference between the processing unit and the
20 base plate onto which the processing unit is attached. In the before-mentioned computer system, the processing unit is attached to a base plate constituted by a print circuit board and having connecting pins extending outwards from the print circuit board parallel to the print circuit board. However, in the alternative embodiment shown, the processing unit is attached to a base plate 35 having leggings 36 extending perpendicular outwards from a
25 bottom side 37 of the base plate 35 and establishing connection between the processing unit 27, which is placed in the middle of the base plate 35, and a socket 37 on the motherboard (not shown) and thus the rest of the computer system.

The leggings 36 are intended for extending through holes 38 in the socket 37 that is to be
30 mounted on the motherboard of the computer system, however, in such a way that the socket 37 and the base plate 35 lie parallel to the motherboard. Contrary to this, the processing unit that the before-mentioned cooling unit is intended for is being placed on a separate print circuit board mounted perpendicular to the motherboard, and not parallel with the motherboard, in a slot on the motherboard. The difficulty of the processing unit

shown here in fig. 14 is that the socket 37 and the base plate 35 are parallel with the motherboard, thereby limiting the access to a top surface 39 of the base plate 35.

The socket is a standard component of the computer system. As mentioned, the socket
5 37 is provided with holes 38 through which the leggings 36 of the base plate 35 extend. The socket 37 itself is mounted on the motherboard (not shown). Along the circumference, the socket 37 is provided with small protrusions 40 extending outwardly from the circumference of the socket. The socket 37 is also provided with a lever arm 41 intended to be handled for securing the socket to the motherboard by appropriate
10 securing means, after the socket has been placed on the motherboard. The socket 37 is only intended as an intermediate means between the motherboard and the base plate 35 of the processing unit in order to avoid that the base plate, having small and fragile leggings 36, have to placed directly on the motherboard.

15 A heating foil 42 is introduced above the base plate 35 and is intended for abutting the top surface 39 of the base plate. The heating foil 42 has a rectangular shape with a rectangular hole 43 in the middle of the heating foil. The shape is established so that the foil is abutting the top surface 39 of the base plate 35 corresponding to the position of the leggings 36 extending from the bottom side of the base plate 35. The hole in the middle
20 allows the processing unit 27 to protrude through the heating foil 42 so that the top of the processing unit can have abutting contact established with the heat exchanger 33. Electrical wires 44 lead to the heating foil 42 in order to heat the foil by means of electrical resistive wiring (not shown) on the heating foil. The heating foil 42 is intended for heating of the leggings 36 in order to prevent any moist condensing on the leggings because of
25 any low temperatures originating from the cooled processing unit 27 and dissipating to the leggings. Accordingly, by heating the leggings separately from cooling the processing unit, then any dew on the leggings can be avoided, thus avoiding any unintentional short-cut between the leggings.

30 The heat exchanger 33 has a circular cylindrical shape. The heat exchanger 33 is surrounded by insulation 16. A spring member 45 being a spiral spring is provided above the heat exchanger 33 and is compressed between a top 46 of the heat exchanger 33 and the interior of an end 47 of the box. The spring member 45 is intended for biasing the heat exchanger 33 towards the processing unit 27. Also the spring member 45 is surrounded
35 by insulation 48.

The box 13 is divided into two halves and the box contains the heat exchanger 33, the spring member 45 and the insulation 16,48. The box 13 is provided with a first opening (not shown) directed towards the heating foil 42, the base plate 35 and the socket 37. An orifice (not shown) of the opening is intended for abutting the heating foil 42 and via the heating foil resting against the base plate 35. The orifice has a circumference with edges 49 having a length l . The length l is approximately the same as an edge length of the heating foil 42 and the base plate 35. Thus, the box 13 does not take up more space than the base plate 35. This ensures that the box can be placed on the base plate 35 irrespective of eventual lack of space beside the base plate when the socket 37 and the base plate 35 are placed on the motherboard of the computer system.

The two halves of the box 13 are mutually joined by means of bolts 19 and nuts 20. At the end 47, the box 13 has a second opening 50 through which the pipes 34 pass to and from the heat exchanger 33. Outside the box 13, the pipes 34 are provided with insulation 4. The end 47 of the housing is provided with a first part 51 of a biasing member. The first part 51 of the biasing member has a hole 52 through which the second opening 50 of the box protrudes and the first part 51 of the biasing member is thereby fixed in relation to the box 13. Second parts 53 of the biasing member have small holes 54 intended for engagement with the small protrusions 40 on the circumference of the socket 37. The first part 51 and the second parts 53 of the biasing member are intended for being mutually joined by means of proper fastening means such as bolts 55 and nuts (not shown) at opposing ends 56,57 of the biasing members.

The biasing member 51,53 shown has the advantage that it is possible to evenly and adjustably bias the box 13 towards the socket 37 and thereby also evenly and adjustably biasing the orifice of the box towards the heating foil 42 and the base plate 35. This ensures that the heating foil 42, the base plate 37 and via the spring member 45 the top of the processing unit 27 are not damaged due to unevenly biasing of the box 13 towards the base plate 35 or due to a too great a force applied to the box. Apart from the spring member 45 biasing the heat exchanger 33 towards the processing unit 27, other spring members (not shown) could be provided in connection with and along the bolts 55 and nuts of the biasing member 51,53 in such a way that the force exerted when tightening the bolts and nuts will pass through the other spring members. Thereby, the force applied when tightening the bolts 55 and nuts would not exceed the spring force of such other spring members, as long as such spring members were not fully compressed.

In a preferred embodiment of the box 13, the box is made of plastic and is provided with a metal foil or is coated with a metallic film either on an interior surface or an exterior surface of the box. Thereby, it is avoided that moisture from the ambient surroundings migrate through the box that may be permeable to moisture and into the insulation 16,48 surrounding the heat exchanger 33 and the spring member 35. Moisture in the insulation 16,48 will decrease the efficiency of the heat exchanger 33 and may damage the insulation itself. Alternatively, the box 13 may be made of a material impermeable to moisture such as metal like cast aluminium.

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Fig. 14A shows a cross section of a preferred embodiment of heat exchanger to be used in a cooling unit as shown in fig. 14. The heat exchanger 33 may be made in any suitable manner, however, the preferred way of producing the heat exchanger is to sinter together small metal balls 71 and provide an outer metal shelf 72 around the sintered metal balls.

15 A preferred metal is copper having a good thermal conductance. Spacing 73 between the metal balls 71 provides passages for the liquid refrigerant to pass through the heat exchanger, and the metal shelf 72 provides an enclosure for the liquid refrigerant. The small metal balls 71 provide easy dissipation of the cold temperature of the liquid refrigerant to the outer shelf 72 of the heat exchanger.

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A central bore 74 is provided along the centre of the heat exchanger. The bottom part of the sintered metal balls 71 is configured like a cone. Via a first pipe (not shown) leading from the compressor through a condenser to the heat exchanger, the liquid refrigerant is passed through the central bore 74 forward to a bottom 75 of the heat exchanger. The liquid refrigerant is then led from the bottom 75 of the heat exchanger backwards into the passages 73 between the sintered metal balls 71. After having passed through the passages 73, the refrigerant, via the passages, is led back to the bottom 75 and into a second pipe (not shown) configured co-axially with the first pipe and leading from the bottom of the heat exchanger to the compressor. An outer end surface 56 of the bottom 75 of the cylindrical heat exchanger is in thermal abutting contact with the processing unit 27 provided in the middle of the base plate 35 (see fig. 14). By providing a central bore 71, it is assured that the liquid refrigerant initially is passed to the bottom 75 and thus cools down the end surface 56 of the heat exchanger, the part of the heat exchanger being in thermal contact with the processing unit. It is also assured that the refrigerant subsequently is passed through the entire heat exchanger before finally being led out of

the heat exchanger. Because of the insulation 16 (see fig. 14) and because of the easy and controlled passage of the liquid refrigerant into, through and out of the heat exchanger, the cooling takes place fast and efficient. Also, the type of heat exchanger is easy and cheap to produce.

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Fig. 15 and fig. 16 show a possible embodiment of a separate cooling system functioning as an air conditioning equipment for cooling the interior of computer cabinets. The separate cooling system is constituted by a casing 60 containing a compressor and a heat exchanger and an evaporizer, none of which are shown. A front 61 of the casing 60
10 comprises an upper grate 62 through which air from the exterior surroundings is being pulled into the casing by means of a fan (not shown) inside the casing. The air pulled through the upper grate 62 is led past an evaporizer (not shown) cooling the air by evaporating a cooling liquid coming from the compressor within the casing. The air passed through the evaporizer is led further through the casing 60 and through a hose 63
15 being coupled to a back 64 of the casing 60. The hose 63 leads to a computer cabinet (not shown) so that the air that has been cooled by the cooling system is led directly to the interior of the computer cabinet. The front 61 of the casing 60 also comprises a lower grate 65 being used for letting air into the casing, the air being passed through a condenser (not shown), where the liquid refrigerant is condensed. The air passed through
20 the condenser is led further through the casing 60 and through a grate 66 at the back 64 of the casing 60.

The front 61 of the casing 60 furthermore comprises a switch button 67 for switching the power to the cooling system off and on and comprises a display 68 for showing the
25 temperature of the air being led through the hose to the computer cabinet. Lamps 69,70, as example one being green and one being red, indicates whether the temperature is below, indicated by the green lamp, a chosen temperature such as 10° C, or is above the chosen temperature, indicated by the red lamp. Other means may be used for showing the status of the cooling system.

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Thus, the casing 60 is provided with all the means of a cooling system and the cooling system may be implemented in any situation where the possibility exists of employing a pipe or a hose to a computer cabinet. When using the separate cooling system, there is no need for integrating the cooling system into the computer cabinet itself, but the cooling
35 of the entire interior of the cabinet may take place by use of the separate cooling system.

However, the efficient cooling of the processing unit itself as described in connection with the previous figures is not possible to establish by means of the separate cooling system, thus the cooling system will mostly be employed as a supplement to the direct contact cooling between a heat exchanger and the processing unit. Alternatively, the system casing may be employed in stead of the direct cooling of the processing unit if the cooling by means of the cooling system is satisfactory or if it is other components of the computer system than a processing unit that set the limit for the performance of the computer system.

CLAIMS

1. A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit generating thermal energy when
5 processing and said cooling system comprising a heat exchanger intended for being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having leggings extending parallel outwards from the base member, said leggings being intended for extending through openings in a slot mounted
10 on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling unit comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulator for at
15 least starting and stopping the compressor and where the compressor is a low voltage compressor with a voltage usage below the voltage of the public electrical power distribution network.
2. A computer system according to claim 1, wherein the low voltage compressor is
20 intended for voltages in the range from 6V to 48V, preferably is intended for voltages in the range from 6V to 12V, most preferably is intended for voltages of 12 V.
3. A computer system according to claim 1 or claim 2, wherein the regulating means is capable of variable regulating the rotational speed and thereby the capacity of the
25 compressor, preferably by regulating the speed infinitely, alternatively by regulating the speed stepwise.
4. A computer system according to claim 3, wherein the regulating means is regulated by a software means controlled by the computer system, alternatively that the regulating
30 means is regulated by hardware means preferably also controlled by the computer system, alternatively controlled by components other than those of the computer system.

5. A computer system according to any of the preceding claims, wherein the processing unit and the heat exchanger both are enclosed in an insulation material and that the insulation material is provided between at least the heat exchanger and the ambient environment, preferably also between the processing unit and the ambient environment.

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6. A computer system according to claim 5 wherein the processing unit and the heat exchanger both are enclosed in a box, that insulation material is provided between at least the heat exchanger and the inside of the box, preferably also between the processing unit and the inside of the box.

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7. A computer system according to any of the preceding claims, wherein a heating element is in contact with the outside of the box, alternatively is in contact with the inside of the box, where the heating element consists of resistive wires, that the wires are in contact with the insulation, alternatively are in contact with the box, and that electrical
15 power is supplied to the resistive wires for providing a heating of the wires and to the insulation, alternatively a heating of the inside or the outside of the box.

8. A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy
20 when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having leggings extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system, and where the heat exchanger constitutes an
25 individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with
30 the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit.

9. A computer system according to claim 8, where the force is applied by means of spring members being attached between the heat exchanger and the socket.

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10. A computer system according to claim 8 or claim 9, where the heat exchanger is contained in a box and where the force is applied by means of spring members being attached between the box and the socket.
- 5 11. A computer system according to claim 10, where the box is provided with a first opening intended for receiving the heat exchanger and a second opening intended for receiving the pipes to and from the heat exchanger, and where the first opening is directed towards the base plate and the socket and has an orifice having circumferential measures being approximately the same as, alternatively smaller than, external measures
10 of the base plate and the socket.
12. A computer system according to any of claim 10 or claim 11, where the box is biased towards the base plate by means of biasing members, where the biasing members is attached between the box and the socket onto which the base plate is mounted.
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13. A computer system according to claim 12, where the biasing members consist of at least one first part attached to the box and at least one second part attached to the socket, and where opposing ends of the first part and the second part are intended for being biased towards each other by fastening means, preferably adjustable fastening
20 means such as bolts and nuts.
14. A computer system according to claim 13, where other spring members are provided in connection with the fastening means, and where biasing of the first part and the second part of the biasing means takes place via the other spring members so that a biasing force
25 between the box and the base plate, and thereby between the heat exchanger and the processing unit, is limited by a spring force of the spring members.
15. A computer system according to any of claims 8-15, and where the heat exchanger consists of metallic balls being in close proximate contact with each other, preferably
30 being sintered together, and where passages are formed between the balls, and where said passages form passages for the cooling refrigerant to pass through the heat exchanger.

16. A computer system according to claim 15, and where the heat exchanger has a circular cylindrical shape, and where an end surface of the cylinder is in abutting contact with a top surface of the processing unit.
- 5 17 A computer system according to any of claims 8-16, wherein only the heat exchanger is enclosed in an insulation material, and where the insulation material is provided between the heat exchanger and the ambient environment.
18. A computer system according to any of claims 8-17, wherein only the heat exchanger
10 is enclosed in a box, and where insulation material is provided between the heat exchanger and the inside of the box.
19. A computer system according to any of claims 8-18, wherein a heating element is in contact with the leggings extending from a bottom surface of the base plate of the
15 processing unit, alternatively is in contact with a top surface of the base plate, where the heating element consists of resistive wires, and that electrical power is supplied to the resistive wires for providing a heating of the leggings and alternatively also of the base plate.
- 20 20. A computer system according to any of the preceding claims, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer
- 25 21. A computer system according to any of the preceding claims, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.
- 30 22. A computer system according to any of the preceding claims, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the

compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

23. A computer system according to any of claims 1-18, wherein at least the compressor,
5 preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

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24 A computer system according to any of the preceding claims, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low
15 compared to metallic materials.

25. A computer system according to any of the preceding claims, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and
20 the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

26. A computer system according to any of the preceding claims, wherein at least an
25 outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

27. A computer system according to any of the preceding claims, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture
30 impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

28. A computer system according to any of the preceding claims, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from
35 the heat exchanger to the compressor in parallel, and that the first pipe in immediate

vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

5 29. A computer system according to any of the preceding claims wherein the heat exchanger is made of copper and that the pipes is made of copper and that the pipes and the heat exchanger are mutually able of being disconnected.

30. A cooling system for a computer system, said computer system comprising a number
10 of electronic components generating thermal energy when being employed and said cooling system constituting a separate cooling system with a fan for sucking air from the surroundings into the cooling system, and a heat exchanger for cooling the air being sucked into the cooling system, and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting
15 the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and further on to the condenser, and said cooling system further comprising a means for passing air, that has been sucked past the heat exchanger and thereby has been cooled by the cooling system, to the interior of a cabinet of a computer system

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COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

BACKGROUND OF THE INVENTION

- 5 The present invention relates to a computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said computer system also comprising a cooling system with a heat exchanger being in thermal contact with the CPU and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting
- 10 the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulating means for at least starting and stopping the compressor.
- 15 It is known to cool the processor of a computer system in order to increase the operating frequency of the processor to a value above the value intended or expected by the producer of the processor. Whenever a processing unit of a computer system is processing, heat is generated. This reduces the working capacity of the unit, and therefore it is desirable to cool the processing unit by means of a cooling system in order
- 20 to increase the processing frequency of the processor.

DESCRIPTION OF THE PRIOR ART

- US 5.574.627 describes such a cooling system. The system comprises a heat exchanger
- 25 being in contact with a central processing unit. The CPU is attached to a so-called motherboard. A refrigeration compressor unit such as the one used in a conventional refrigerator provides the cooling. Similar cooling unit is further described at homepage www.kryotech.com from the company Kryotech, Inc. Around the CPU and around the heat exchanger, insulation is provided. The insulation ensures that any dew that may be
- 30 generated on the cool surface of the heat exchanger or on the cooled down surface of the processor is avoided. However, if dew never the less should generate on the insulation, resistive ink is provided at the outer surface of the insulation in order to heat the insulation if necessary.

This cooling system described in this patent and also the system described at the web-site www.kryotech.com have some disadvantages. Firstly, the compressor used is very bulky compared to the rest of the components of the computer system which all should be as small as possible for fulfilling the demands of small sized computers. The compressor
5 is a conventional compressor using high voltage power supply such as 220/230 V or 110/115 V. This creates the need for extra electrical insulation and other measures for maintaining a sufficient electrical security. Also, the heat generated by the compressor will to a certain extend be conducted up through the computer itself and past the components of the computer system thereby increasing the internal temperature of the casing of the
10 compressor.

US 5.488.279 describes using a low-voltage compressor to be used in an electrical refrigerator working at locations away from an access to the public electrical network such as off a battery incorporated in an automobile. Thus, using a low-voltage compressor in a
15 refrigerator in an automobile is due to the necessity of using a compressor, which is capable of running on electrical power having a voltage level corresponding to the voltage level that an automobile can provide. There is no discussion of the possible advantages of using a low voltage compressor in stead of using a high voltage compressor, namely because using a low voltage compressor is a necessity and not an option when using it in
20 an electrical refrigerator in an automobile.

US 6.054.676 describes an apparatus for cooling an integrated circuit. The cooling unit comprises casings enclosing a base plate that the integrated circuit is mounted to. Inside the casing a cold plate is provided. The cold plate is situated, together with the integrated
25 circuit, within the casing, and the casing provides insulation around the cold plate. The apparatus also comprises a heating foil being provided with holes along the periphery of the foil. Leggings extending from the base plate extend through the holes in the heating foil. The cooling of the integrated circuit and the heat exchanger is dependant on the insulating capacity of the casing, and the thermal contact between the cold plate and the
30 integrated circuit is limited because there is no means for establishing a close physical contact between the cold plate and the integrated circuit.

US 5,539,155 describes an apparatus for cooling an integrated circuit chip. The apparatus comprises a cooling pipe being in contact with a pad, said pad being in contact with a
35 surface of the circuit chip. The cooling pipe is maintained to the pad by means of a

number of clips and the pad is kept in place on top of the surface of the circuit chip by means of holding fixture with a hole through which the pad extends. The holding fixture is secured to the motherboard by means of screws at each side of the circuit chip. This apparatus has the disadvantage that a substantial temperature gradient exists between
5 the cooling pipe and the pad, thus limiting the cooling of the pad. Furthermore, the pad is kept in place by means of a holding fixture taking up a lot of space. Such space is seldom available on a motherboard. If the space is made available, such space severely limits the possibility of decreasing the space taken up by the electronic components in common. Finally, it may be very difficult to gain access with a screwdriver for securing the holding
10 fixture to the motherboard.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a computer system with a cooling system
15 where the flexibility of using the cooling system is greater than for known systems and where the risk of electrical damage or lack of electrical security is reduced so that the overall functionality of the computer system is increased.

This purpose is obtained by a computer system where the compressor is a low voltage
20 compressor with a voltage usage below the voltage of the public electrical power distribution network.

Using the public net is obvious because the computer system itself always has the need for electrical power from the public net, so there is no reason why the compressor should
25 not also have electrical power from the public net. However, by using a low voltage compressor certain surprising advantages are obtained compared to using conventional high voltage compressors adapted for using the voltage supply of the public electrical distribution net, although special supplementary features are needed in the computer system, which may cause disadvantages which do not occur when using high voltage
30 compressors. However, the advantages obtained when using low voltage compressor may justify the disadvantages involved.

A first advantage of using a low voltage compressor is that it is possible to power the compressor from the electrical power supply of the computer system itself, thereby
35 eliminating the need for a supplementary power supply. It also means that using the

computer with different networks as example 220/230 V or 110/115 V is indifferent to the compressor because the power is supplied from the power supply of the computer system. Any switch between as example 220 V and 110 V will just have to be made for the components of the computer, and the compressor neither needs to be suited for the
5 actual voltage of the electrical distribution network nor needs to have a switch of its own for switching between different voltages of networks around the world.

A second advantage of using a low voltage computer is that it is very easy to incorporate means for regulating the capacity of the compressor. This makes it possible to individually
10 graduate the degree of lowering the temperature and also makes it possible to adjust the capacity in response to the need for cooling. As example, when the computer system is in a standby mode or in any other way is not performing greater processing, then the need for cooling is limited as compared to situations when the processor is performing actual processing. The means for regulating the capacity of the compressor may be controlled
15 by additional software incorporated in the computer system. The means for regulation may also be more conventional regulating means or a combination of these and software controlling.

A third advantage is that the size of a low voltage compressor may be smaller than the
20 size of a conventional high voltage compressor. This means that the space needed for the cooling system is limited and advantageously the cooling system may be incorporated into the standard cabinet of the computer system. Also, the power consumption of a low voltage compressor is lower than that of conventional high voltage compressors, as example 50W compared to 120W. Apart from reducing the overall power consumption of
25 the computer system, the reduced power consumption may also limit the size of certain electrical components in the compressor.

Also it is possible to incorporate the compressor into the top of the cabinet because not only the size but also the weight of the low voltage compressor may be smaller than for
30 conventional compressors. Accordingly, there will neither be any space problem nor any stability problem of placing the compressor in the top of the cabinet. Placing the compressor in the top of the cabinet means that the heat generated when the compressor is working is not passed through the computer itself and is not passed through the components of the computer system.

In a preferred embodiment the computer system wherein the CPU and the heat exchanger are enclosed in a box, the insulation material is provided between at least the heat exchanger and the inside of the box, preferably is provided also between the CPU and the inside of the box.

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The advantages of enclosing the heat exchanger and the processor in insulation are already known. However, also enclosing the insulation in a box has the advantage that the processor and the insulation are capsuled and constitute a unit of its own. Enclosing the heat exchanger and the processor together with the insulation in a box means that it is actually possible to market and sell these components as an integrated unit.

10 As example, if a computer already having a cooling system has to be upgraded, then it is necessary to substitute the processor. Substituting the processor may involve also substituting the heat exchanger to one with a larger cooling capacity. This can easily be done if the processor, the heat exchanger and the insulation are enclosed in a box

15 constituting a unit. Thereby it is not necessary to dismantle the insulation and the heat exchanger, substituting the processor and afterwards assemble the heat exchanger and the insulation again.

If the box is black and perhaps is also lustreless, then the outside of the box will have the best opportunity to receive heat from the surroundings, and thereby keeping as high a temperature as possible of the box. This avoids the formation of dew on the box. The box may as a supplement be provided with a heating element in thermal contact with the outer or inner surface of the box for heating the box to further avoid the formation of dew.

25 However, in other situations it may only be necessary to substitute the processor, but not absolutely necessary to substitute the heat exchanger. Also in this situation it is convenient to have the processor, the heat exchanger and the insulation all enclosed in a box. It will be possible to dismantle the insulation and the heat exchanger outside of the computer system and thereafter substituting the processor and assemble the insulation

30 and the heat exchanger again also outside the computer and finally placing the box in the computer.

Thus the overall flexibility of the computer system according to the invention is highly increased by the combination of the above mentioned features. This is important in especially this field of business, where the technical development is extremely fast and

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therefore fosters the need of a possibility to substitute one or more components with new components, but also a need for a uniform product that may be used all around the world because most computer systems are universal. Thus using a low voltage compressor makes the computer system according to the invention universal, while using components
5 that are not physically bonded together and which are enclosed in a box constituting a unit at the same time increases the flexibility by facilitating easy substitution of the components.

Another aspect of the present invention is to further increase the cooling of the computer
10 system by means of an exterior cooling system functioning as an air conditioning system for cooling the interior of a computer cabinet. A separate cooling system from which a hose or a pipe leads to the cabinet of a computer system and through which hose or pipe pre-cooled air is let into the computer cabinet has the effect of cooling the entire interior of the cabinet, i.e. the air and thus all components inside the cabinet. The processing units
15 are those that are most relevant to cool and depending on the type of processing unit and the way it is attached to the motherboard the firstly mentioned or the alternative mentioned type of heat exchanger may be employed.

However, a further advantage by cooling can be obtained by also cooling the interior of
20 the computer cabinet. By only cooling the interior of the computer cabinet and not also cooling the exterior surroundings of the cabinet, a much faster and more efficient cooling takes place and it is possible to obtain a certain cooling rate by means of only a smaller cooling system. Lastly, it is possible to take the cooling system along to the computer to be cooled, thus not being restricted to cooling the computers being situated in a certain
25 room being provided with air condition for the entire room, i.e. where also the exterior surroundings of the computer cabinets being cooled in such a room.

BRIEF DESCRIPTION OF THE INVENTION

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The invention will now be described in detail with reference to the accompanying drawing, where

fig. 1 shows an embodiment of a computer system with a cooling system according to the
35 invention with a cooling unit enclosed in a box that is mounted in the computer system,

- fig. 2 shows a cooling system mounted in the top of a computer cabinet and comprising a compressor and an external heat exchanger,
- fig. 3 shows the box with the embodiment of the invention enclosed and provided with a heating element around the exterior of the box,
- 5 fig. 4 shows different components of the box enclosing part of the cooling system according to the invention
- fig. 5 - fig. 13 show different steps in assembling the components inside the box and in assembling the box itself,
- fig. 14 shows an alternative embodiment of the invention enclosed in a box that is
- 10 alternatively mounted in a computer system,
- fig. 14a shows a cross section of an embodiment of a heat exchanger to be used in the alternatively mounted box, and
- fig. 15 and fig. 16 shows an embodiment of a separate cooling system for cooling the interior of a computer cabinet.

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DETAILED DESCRIPTION OF THE INVENTION

- Fig. 1 is a photograph showing a motherboard 1 inside a computer cabinet 2. At the
- 20 motherboard 1 a black box 3 is shown. The box 3 encloses the central processing unit (CPU) (not shown) of the computer system. Apart from enclosing the CPU, the box also encloses a cooling unit comprising a heat exchanger (not shown) being in thermal contact with the CPU. The box is kept in place by means of the connection pins from the printed circuit board at which the CPU is placed (see fig. 6), said connection pins being inserted
- 25 in the appropriate slots in the motherboard. A hose 4 extends from the box 3 to a compressor (see fig. 2). The hose 4 contains metal piping for conducting coolant liquid from the compressor to the heat exchanger in the box and for returning the vaporised coolant from the heat exchanger in the box to the compressor.
- 30 Fig. 2 is a photograph showing the part of the cooling system being outside the box (see fig. 1), i.e. all of the cooling system, except the parts inside the box including the heat exchanger being in thermal contact with the CPU. The cooling system comprises a compressor 5. The compressor 5 is a special low voltage compressor, preferably a 12V compressor. A metal piping (not shown) is leading through the hose 4 from the
- 35 compressor 5 to the heat exchanger in the box (see fig. 1), and an other metal piping 6 is

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Apart from being provided with a heating element 8 the box is preferably black and provided with a lustreless surface. Both of these features further minimises the risk of dew occurring because the casing of the box, when being black and lustreless, receives as much heat in the form of radiation heat both from the heating element wrapped around the outer surface of the box but also from the surroundings. Alternatively, the box may have other appearances in relation to colour and surface if the problem of dew occurring is not that great a problem. As example, if it is a greater problem that heat from the surroundings limits the capacity of the heating element inside the box because of heat penetrating through the box and through the insulation, it will be more favourable to have a white box with a shiny surface in order to reject as much of the heating radiating from the surroundings inside the computer system.

Fig. 4 is a photograph showing the different components of a cooling unit in a box shown in fig. 1 and fig. 3. The box 3 consists of a casing consisting of two halves 12,13 (see fig. 5 and fig. 13) and of insulation 14-17 for being placed inside the casing and for surrounding the CPU and the heat exchanger thereby forming a thermal barrier between these components and the casing of the box. Furthermore the box comprises bolts 18,19 and nuts 20 for holding together of the two parts which constitutes the casing (see the subsequent figures). The box also comprises a plate 21 for holding the heat exchanger in a firm physical and thereby firm thermal contact with the CPU. Lastly, as an option, the box comprises the heating element 8 in the form of the foil with wires (see fig. 3) for wrapping around the outer surface of the casing.

Fig. 5 - fig. 13 are photographs showing assembling of the box and of the CPU and the heat exchanger inside the box. Fig. 5 shows a first half part 12 of the casing into which a first layer 14 of insulation is placed. In the right side upper side 22 of the casing an opening 23 is provided for insertion of the tube 4 and the piping into the box 3. The part 12 of the casing and the insulation 14 are provided with holes 24 for accommodating the insertion of the bolts 19 through the insulation 14 and through the box 3. In the bottom 25 of the casing a slot (not shown) is provided through which the connecting pins of the print circuit board can be introduced (see fig. 7).

Fig. 6 shows a print circuit board 26 on which a central processing unit (CPU) 27 is placed. Also other electrical components are placed on the board 26. The board 26 is

provided with connection pins 28 along the lower edge of the board. The pins 28 are intended for insertion into corresponding slots in the motherboard (see fig. 1) of the computer system. Bolts 18 are attached to the print circuit board 26. The bolts 18 are for fastening of the plate 21 for keeping the heat exchanger in place in relation to the
5 insulation and the casing of the box (see fig. 11). The board 26 is also provided with holes 29 for accommodating the insertion of the bolts 19 through the board.

Fig. 7 shows the print board circuit 26 as shown in fig. 6 placed in the half part 12 of the casing as shown in fig. 5. The connecting pins 28 on the print circuit board 26 are inserted
10 through the slot (not shown) in lower part 25 of the part 12 of the casing so that the pins 28 extrude outside of the casing. Thereby the box may be fixed to the motherboard of the computer system by just inserting the connecting pins of the print circuit board in the corresponding slots in the motherboard (see fig. 1).

15 Fig. 8 shows a first intermediate layer 15 of insulation placed on top of the print circuit board 26 (see fig. 7). A rectangular opening 30 is made in the first intermediate layer 15 of insulation so that the CPU 28 is still exposed. The first intermediate layer 15 of insulation is provided with four holes (not shown) in the sides of the insulation through which the guiding bolts 18 and the bolts 19 for assembling the casing are extending.

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Fig. 9 shows a second intermediate layer 16 of insulation placed above the first intermediate layer 15 shown in fig. 8. The second intermediate layer 16 is provided with a rectangular opening 31 that is bigger than the opening 30 in the first intermediate layer 15 and intended for receiving the heat exchanger (see fig. 10). The second intermediate
25 layer 16 is provided with a groove 32 extending from the opening 31 to the one side of the layer. The groove 32 is intended for receiving piping (see fig. 10) leading to and from the heat exchanger (see fig. 10). Also, the second intermediate layer 16 of insulation is provided with four holes (not shown) in the sides of the insulation through which the fastening bolts 18 and the assembling bolts 19 for assembling the casing are extending.

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Fig. 10 shows a heat exchanger 33 placed in the insulation in the casing. The heat exchanger 33 consists of a square block inside which canals (not shown) are made for the coolant to flow through the heat exchanger. The heat exchanger 33 is accommodated in the opening 31 of the second intermediate layer 16 of insulation (see fig. 9). Piping 34
35 leads the coolant to and from the heat exchanger 33. The piping 34 consists of an outer

pipe with a larger diameter and an inner pipe with a smaller diameter. The inner pipe extends co-axially and inside the outer pipe. The tube 4 surrounding the piping 34 is shown outside the casing. The tube 4 is insulated so that the piping 34 leading between the heat exchanger 33 and the compressor 5 (see fig. 2) is thermally insulated from the 5 surroundings.

Fig. 11 shows the plate 21 for keeping the heat exchanger 33 in place. The plate 21 is provided with holes (not shown) through which the fastening bolts 18 and assembling bolts 19 are extending. Nuts 20 are screwed onto the bolts 18,19 so that the plate 21 is 10 kept in place against the heat exchanger 33 thereby assuring sufficient physical and thermal contact between the heat exchanger 33 and the CPU 27. Both the fastening bolts 18 and the assembling bolts 19 and the nuts 20 are made of plastic having a poor thermal conductivity. Thereby the bolts 18,19 and the nuts 20 will not be responsible of thermal 15 transportation of energy either heat from the surroundings to the metal plate 21 and further on to the heat exchanger 33 or cold from the heat exchanger 33 and further on to the metal plate 21 and to the surroundings.

Fig. 12 shows a final layer 17 of insulation placed above the already mounted components in the box. The final layer is provided with two holes (not shown) through 20 which the assembling bolts 19 extend.

Fig. 13 shows a second half part 13 of the casing of the box placed above all of the components inside the box and thereby enclosing these components in the box. The second half 13 of the casing is provided with two holes (not shown) through which the 25 assembling bolts 19 extend. Nuts 20 are screwed onto the bolts 19 for assembling the two halves 12,13 of the box. The box is now closed. The piping (not shown) extend out through the hole 23 (see fig. 5) in the upper right side of the box and is being provided with the tube 4 around it. The connecting pins 28 of the print circuit board 26 (see fig. 6) extend through the slot (not shown) in the bottom of the box.

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In the embodiment shown of the computer system according to the invention different alterations may be induced without departing from the scope of protection. As mentioned, it will be possible to exclude using the heating element wrapped around the box as shown in fig. 3. It will also be possible to use low voltage compressors with other voltage needs 35 than 12V, as example 6V, 24V or 48V. Also, in stead of using electrical power from the

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shown here in fig. 14 is that the socket 37 and the base plate 35 are parallel with the motherboard, thereby limiting the access to a top surface 39 of the base plate 35.

The socket is a standard component of the computer system. As mentioned, the socket
5 37 is provided with holes 38 through which the leggings 36 of the base plate 35 extend.
The socket 37 itself is mounted on the motherboard (not shown). Along the
circumference, the socket 37 is provided with small protrusions 40 extending outwardly
from the circumference of the socket. The socket 37 is also provided with a lever arm 41
intended to be handled for securing the socket to the motherboard by appropriate
10 securing means, after the socket has been placed on the motherboard. The socket 37 is
only intended as an intermediate means between the motherboard and the base plate 35
of the processing unit in order to avoid that the base plate, having small and fragile
leggings 36, have to placed directly on the motherboard.

15 A heating foil 42 is introduced above the base plate 35 and is intended for abutting the top
surface 39 of the base plate. The heating foil 42 has a rectangular shape with a
rectangular hole 43 in the middle of the heating foil. The shape is established so that the
foil is abutting the top surface 39 of the base plate 35 corresponding to the position of the
leggings 36 extending from the bottom side of the base plate 35. The hole in the middle
20 allows the processing unit 27 to protrude through the heating foil 42 so that the top of the
processing unit can have abutting contact established with the heat exchanger 33.
Electrical wires 44 lead to the heating foil 42 in order to heat the foil by means of electrical
resistive wiring (not shown) on the heating foil. The heating foil 42 is intended for heating
of the leggings 36 in order to prevent any moist condensing on the leggings because of
25 any low temperatures originating from the cooled processing unit 27 and dissipating to the
leggings. Accordingly, by heating the leggings separately from cooling the processing
unit, then any dew on the leggings can be avoided, thus avoiding any unintentional short-
cut between the leggings.

30 The heat exchanger 33 has a circular cylindrical shape. The heat exchanger 33 is
surrounded by insulation 16. A spring member 45 being a spiral spring is provided above
the heat exchanger 33 and is compressed between a top 46 of the heat exchanger 33
and the interior of an end 47 of the box. The spring member 45 is intended for biasing the
heat exchanger 33 towards the processing unit 27. Also the spring member 45 is
35 surrounded by insulation 48.

The box 13 is divided into two halves and the box contains the heat exchanger 33, the spring member 45 and the insulation 16,48. The box 13 is provided with a first opening (not shown) directed towards the heating foil 42, the base plate 35 and the socket 37. An
5 orifice (not shown) of the opening is intended for abutting the heating foil 42 and via the heating foil resting against the base plate 35. The orifice has a circumference with edges 49 having a length l . The length l is approximately the same as an edge length of the heating foil 42 and the base plate 35. Thus, the box 13 does not take up more space than the base plate 35. This ensures that the box can be placed on the base plate 35
10 irrespective of eventual lack of space beside the base plate when the socket 37 and the base plate 35 are placed on the motherboard of the computer system.

The two halves of the box 13 are mutually joined by means of bolts 19 and nuts 20. At the end 47, the box 13 has a second opening 50 through which the pipes 34 pass to and from the heat exchanger 33. Outside the box 13, the pipes 34 are provided with insulation 4.
15 The end 47 of the housing is provided with a first part 51 of a biasing member. The first part 51 of the biasing member has a hole 52 through which the second opening 50 of the box protrudes and the first part 51 of the biasing member is thereby fixed in relation to the box 13. Second parts 53 of the biasing member have small holes 54 intended for engagement with the small protrusions 40 on the circumference of the socket 37. The first
20 part 51 and the second parts 53 of the biasing member are intended for being mutually joined by means of proper fastening means such as bolts 55 and nuts (not shown) at opposing ends 56,57 of the biasing members.

The biasing member 51,53 shown has the advantage that it is possible to evenly and
25 adjustably bias the box 13 towards the socket 37 and thereby also evenly and adjustably biasing the orifice of the box towards the heating foil 42 and the base plate 35. This ensures that the heating foil 42, the base plate 37 and via the spring member 45 the top of the processing unit 27 are not damaged due to unevenly biasing of the box 13 towards the base plate 35 or due to a to a biasing with to great a force applied to the box. Apart
30 from the spring member 45 biasing the heat exchanger 33 towards the processing unit 27, other spring members (not shown) could be provided in connection with and along the bolts 55 and nuts of the biasing member 51,53 in such a way that the force exerted when tightening the bolts and nuts will pass through the other spring members. Thereby, the force applied when tightening the bolts 55 and nuts would not exceed the spring force of
35 such other spring members, as long as such spring members were not fully compressed.

In a preferred embodiment of the box 13, the box is made of plastic and is provided with a metal foil or is coated with a metallic film either on an interior surface or an exterior surface of the box. Thereby, it is avoided that moisture from the ambient surroundings migrate through the box that may be permeable to moisture and into the insulation 16,48 surrounding the heat exchanger 33 and the spring member 35. Moisture in the insulation 16,48 will decrease the efficiency of the heat exchanger 33 and may damage the insulation itself. Alternatively, the box 13 may be made of a material impermeable to moisture such as metal like cast aluminium.

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Fig. 14A shows a cross section of a preferred embodiment of heat exchanger to be used in a cooling unit as shown in fig. 14. The heat exchanger 33 may be made in any suitable manner, however, the preferred way of producing the heat exchanger is to sinter together small metal balls 71 and provide an outer metal shelf 72 around the sintered metal balls. A preferred metal is copper having a good thermal conductance. Spacing 73 between the metal balls 71 provides passages for the liquid refrigerant to pass through the heat exchanger, and the metal shelf 72 provides an enclosure for the liquid refrigerant. The small metal balls 71 provide easy dissipation of the cold temperature of the liquid refrigerant to the outer shelf 72 of the heat exchanger.

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A central bore 74 is provided along the centre of the heat exchanger. The bottom part of the sintered metal balls 71 is configured like a cone. Via a first pipe (not shown) leading from the compressor through a condenser to the heat exchanger, the liquid refrigerant is passed through the central bore 74 forward to a bottom 75 of the heat exchanger. The liquid refrigerant is then led from the bottom 75 of the heat exchanger backwards into the passages 73 between the sintered metal balls 71. After having passed through the passages 73, the refrigerant, via the passages, is led back to the bottom 75 and into a second pipe (not shown) configured co-axially with the first pipe and leading from the bottom of the heat exchanger to the compressor. An outer end surface 56 of the bottom 75 of the cylindrical heat exchanger is in thermal abutting contact with the processing unit 27 provided in the middle of the base plate 35 (see fig. 14). By providing a central bore 71, it is assured that the liquid refrigerant initially is passed to the bottom 75 and thus cools down the end surface 56 of the heat exchanger, the part of the heat exchanger being in thermal contact with the processing unit. It is also assured that the refrigerant subsequently is passed through the entire heat exchanger before finally being led out of

the heat exchanger. Because of the insulation 16 (see fig. 14) and because of the easy and controlled passage of the liquid refrigerant into, through and out of the heat exchanger, the cooling takes place fast and efficient. Also, the type of heat exchanger is easy and cheap to produce.

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Fig. 15 and fig. 16 show a possible embodiment of a separate cooling system functioning as an air conditioning equipment for cooling the interior of computer cabinets. The separate cooling system is constituted by a casing 60 containing a compressor and a heat exchanger and an evaporizer, none of which are shown. A front 61 of the casing 60
10 comprises an upper grate 62 through which air from the exterior surroundings is being pulled into the casing by means of a fan (not shown) inside the casing. The air pulled through the upper grate 62 is led past an evaporizer (not shown) cooling the air by evaporating a cooling liquid coming from the compressor within the casing. The air passed through the evaporizer is led further through the casing 60 and through a hose 63
15 being coupled to a back 64 of the casing 60. The hose 63 leads to a computer cabinet (not shown) so that the air that has been cooled by the cooling system is led directly to the interior of the computer cabinet. The front 61 of the casing 60 also comprises a lower grate 65 being used for letting air into the casing, the air being passed through a condenser (not shown), where the liquid refrigerant is condensed. The air passed through
20 the condenser is led further through the casing 60 and through a grate 66 at the back 64 of the casing 60.

The front 61 of the casing 60 furthermore comprises a switch button 67 for switching the power to the cooling system off and on and comprises a display 68 for showing the
25 temperature of the air being led through the hose to the computer cabinet. Lamps 69,70, as example one being green and one being red, indicates whether the temperature is below, indicated by the green lamp, a chosen temperature such as 10° C, or is above the chosen temperature, indicated by the red lamp. Other means may be used for showing the status of the cooling system.

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Thus, the casing 60 is provided with all the means of a cooling system and the cooling system may be implemented in any situation where the possibility exists of employing a pipe or a hose to a computer cabinet. When using the separate cooling system, there is no need for integrating the cooling system into the computer cabinet itself, but the cooling
35 of the entire interior of the cabinet may take place by use of the separate cooling system.

However, the efficient cooling of the processing unit itself as described in connection with the previous figures is not possible to establish by means of the separate cooling system, thus the cooling system will mostly be employed as a supplement to the direct contact cooling between a heat exchanger and the processing unit. Alternatively, the system

5 casing may be employed in stead of the direct cooling of the processing unit if the cooling by means of the cooling system is satisfactory or if it is other components of the computer system than a processing unit that set the limit for the performance of the computer system.

CLAIMS

1. A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit generating thermal energy when
5 processing and said cooling system comprising a heat exchanger intended for being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having leggings extending parallel outwards from the base member, said leggings being intended for extending through openings in a slot mounted
10 on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling unit comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and said computer system further comprising a regulator for at
15 least starting and stopping the compressor and where the compressor is a low voltage compressor with a voltage usage below the voltage of the public electrical power distribution network.
2. A computer system according to claim 1, wherein the low voltage compressor is
20 intended for voltages in the range from 6V to 48V, preferably is intended for voltages in the range from 6V to 12V, most preferably is intended for voltages of 12 V.
3. A computer system according to claim 1 or claim 2, wherein the regulating means is capable of variable regulating the rotational speed and thereby the capacity of the
25 compressor, preferably by regulating the speed infinitely, alternatively by regulating the speed stepwise.
4. A computer system according to claim 3, wherein the regulating means is regulated by a software means controlled by the computer system, alternatively that the regulating
30 means is regulated by hardware means preferably also controlled by the computer system, alternatively controlled by components other than those of the computer system.

5. A computer system according to any of the preceding claims, wherein the processing unit and the heat exchanger both are enclosed in an insulation material and that the insulation material is provided between at least the heat exchanger and the ambient environment, preferably also between the processing unit and the ambient environment.

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6. A computer system according to claim 5 wherein the processing unit and the heat exchanger both are enclosed in a box, that insulation material is provided between at least the heat exchanger and the inside of the box, preferably also between the processing unit and the inside of the box.

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7. A computer system according to any of the preceding claims, wherein a heating element is in contact with the outside of the box, alternatively is in contact with the inside of the box, where the heating element consists of resistive wires, that the wires are in contact with the insulation, alternatively are in contact with the box, and that electrical power is supplied to the resistive wires for providing a heating of the wires and to the insulation, alternatively a heating of the inside or the outside of the box.

8. A computer system comprising a cooling system, said computer system comprising at least a processing unit such as a central processing unit (CPU) generating thermal energy when processing and said cooling system comprising a heat exchanger being in thermal contact with the processing unit and where the processing unit is of a type comprising a base plate having legging extending perpendicular outwards from the base member, said legging being intended for extending through openings in a socket mounted on a motherboard of the computer system, and where the heat exchanger constitutes an individual unit separate from the processing unit, and said cooling system comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor, and the heat exchanger being intended for thermal contact with the processing unit by a force directed perpendicular to a top of the processing unit and being intended for biasing the heat exchanger towards the processing unit.

9. A computer system according to claim 8, where the force is applied by means of spring members being attached between the heat exchanger and the socket.

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10. A computer system according to claim 8 or claim 9, where the heat exchanger is contained in a box and where the force is applied by means of spring members being attached between the box and the socket.

- 5 11. A computer system according to claim 10, where the box is provided with a first opening intended for receiving the heat exchanger and a second opening intended for receiving the pipes to and from the heat exchanger, and where the first opening is directed towards the base plate and the socket and has an orifice having circumferential measures being approximately the same as, alternatively smaller than, external measures
10 of the base plate and the socket.

12. A computer system according to any of claim 10 or claim 11, where the box is biased towards the base plate by means of biasing members, where the biasing members is attached between the box and the socket onto which the base plate is mounted.

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13. A computer system according to claim 12, where the biasing members consist of at least one first part attached to the box and at least one second part attached to the socket, and where opposing ends of the first part and the second part are intended for being biased towards each other by fastening means, preferably adjustable fastening
20 means such as bolts and nuts.

14. A computer system according to claim 13, where other spring members are provided in connection with the fastening means, and where biasing of the first part and the second part of the biasing means takes place via the other spring members so that a biasing
25 force between the box and the base plate, and thereby between the heat exchanger and the processing unit, is limited by a spring force of the spring members.

15. A computer system according to any of claims 8-15, and where the heat exchanger consists of metallic balls being in close proximate contact with each other, preferably
30 being sintered together, and where passages are formed between the balls, and where said passages form passages for the cooling refrigerant to pass through the heat exchanger.

16. A computer system according to claim 15, and where the heat exchanger has a circular cylindrical shape, and where an end surface of the cylinder is in abutting contact with a top surface of the processing unit.
- 5 17 A computer system according to any of claims 8-16, wherein only the heat exchanger is enclosed in an insulation material, and where the insulation material is provided between the heat exchanger and the ambient environment.
18. A computer system according to any of claims 8-17, wherein only the heat exchanger
10 is enclosed in a box, and where insulation material is provided between the heat exchanger and the inside of the box.
19. A computer system according to any of claims 8-18, wherein a heating element is in contact with the leggings extending from a bottom surface of the base plate of the
15 processing unit, alternatively is in contact with a top surface of the base plate, where the heating element consists of resistive wires, and that electrical power is supplied to the resistive wires for providing a heating of the leggings and alternatively also of the base plate.
- 20 20. A computer system according to any of the preceding claims, wherein the components of the cooling system is provided with means for placing the components inside a standard cabinet of the computer system, and that said means is shaped so that the means may be placed in slots inside the computer system, alternatively may be attached to boards of the computer
25
21. A computer system according to any of the preceding claims, wherein the compressor is supplied with electrical power from the built-in power supply of the computer, which power supply also is intended for powering other components of the computer, such as data-processing components.
30
22. A computer system according to any of the preceding claims, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 5 1/4 inches, where the frame has dimensions of about 5 1/4 inches and that the frame with the

compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

23. A computer system according to any of claims 1-18, wherein at least the compressor, preferably at least the compressor and the condenser, is/are mounted on a frame, where the compressor and the condenser have dimensions smaller than 3 1/2 inches, where the frame has dimensions of about 3 1/2 inches and that the frame with the compressor and the condenser mounted is capable of being displaced in and out of built in drive bay shafts on the front side of a computer cabinet.

10

24 A computer system according to any of the preceding claims, wherein the box is a plastic box having a thermal conductivity lower than that of metallic materials and that the box consists of at least two parts that are mutually connected by connection means and that the connection means are made of a material with thermal conductivity that is low compared to metallic materials.

15

25. A computer system according to any of the preceding claims, wherein the heat exchanger only is in thermal contact with the processing unit, and that the heat exchanger and the processing unit is separable so that the processing unit may be substituted and the heat exchanger may be thermally connected to a substitutive processing unit, alternatively that the heat exchanger may be substituted and the processing unit may be thermally connected to a substitutive heat exchanger.

20

26. A computer system according to any of the preceding claims, wherein at least an outer surface of the box is black and preferably is also lustreless, so that the box is capable as easy as possible to receive heat from the ambient environment.

25

27. A computer system according to any of the preceding claims, wherein the box on an inner surface, alternatively on an outside surface, of the box is provided with a moisture impermeable coating, preferably a metallic coating such as a metallic foil or a metallic film, so that insulation inside the box is prevented from absorbing moisture.

30

28. A computer system according to any of the preceding claims, wherein the first pipe and the second pipe are led from the compressor to the heat exchanger respectively from the heat exchanger to the compressor in parallel, and that the first pipe in immediate

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vicinity of the heat exchanger has a smaller cross section than the second pipe, and that the first pipe when entering the heat exchanger is led into the second pipe and is led into the heat exchanger co-axially with the second pipe.

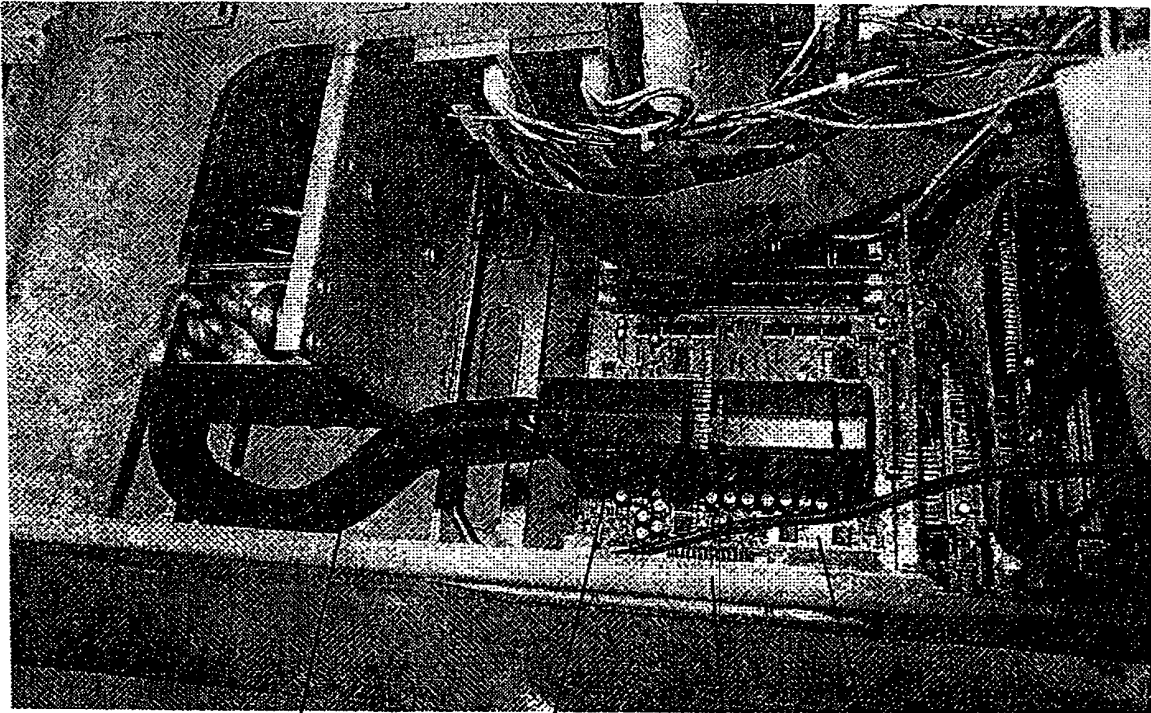
5 29. A computer system according to any of the preceding claims wherein the heat exchanger is made of copper and that the pipes is made of copper and that the pipes and the heat exchanger are mutually able of being disconnected.

30. A cooling system for a computer system, said computer system comprising a number
10 of electronic components generating thermal energy when being employed and said cooling system constituting a separate cooling system with a fan for sucking air from the surroundings into the cooling system, and a heat exchanger for cooling the air being sucked into the cooling system, and comprising a compressor for compressing cooling refrigerant from a vaporised state to a liquid state and comprising first pipes transporting
15 the cooling refrigerant from the compressor to the heat exchanger and second pipes leading the cooling refrigerant from the heat exchanger back to the compressor and further on to the condenser, and said cooling system further comprising a means for passing air, that has been sucked past the heat exchanger and thereby has been cooled by the cooling system, to the interior of a cabinet of a computer system

ABSTRACT

The invention relates to a computer system incorporating a cooling unit. The cooling unit uses conventional coolant that is being led from a compressor to a heat exchanger being
5 in thermal contact with a component in the computer system generating heat, as example a central processing unit (CPU). The compressor is a low voltage compressor although the computer system has to have high voltage electrical power from the public electricity distribution net. By using a low voltage compressor the demands for power consumption and space may be limited. Also, it is possible to power the compressor from the built-in
10 power supply of the computer system. In a preferred embodiment the heat exchanger being in thermal contact with the processing unit is enclosed in an insulated box. The box has openings for piping leading the coolant to and from the heat exchanger, and the box preferably also has a slot so that connection pins from the printed circuit board of the processing unit can protrude put through the box. Thereby the box can be attached to the
15 motherboard by means of the connection pins. An alternative box has an orifice intended for abutting a base plate of the processing unit and has biasing means for holding the box onto a socket for the base plate and in abutment with the base plate.

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Fig. 1

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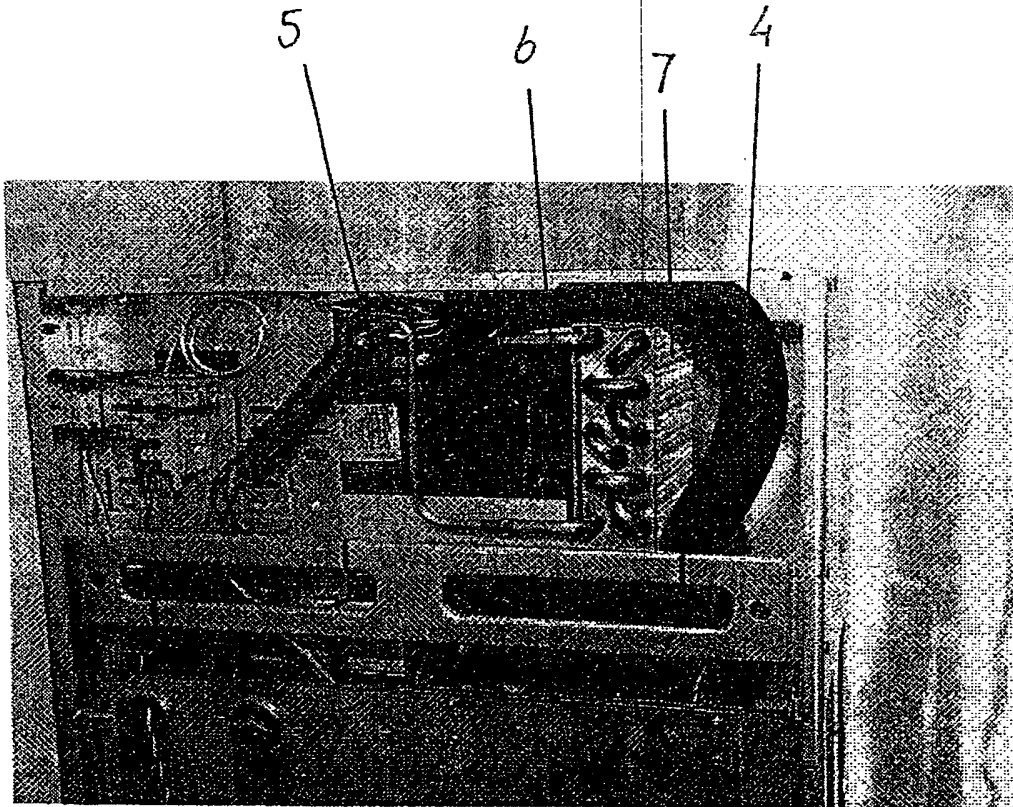


Fig. 2

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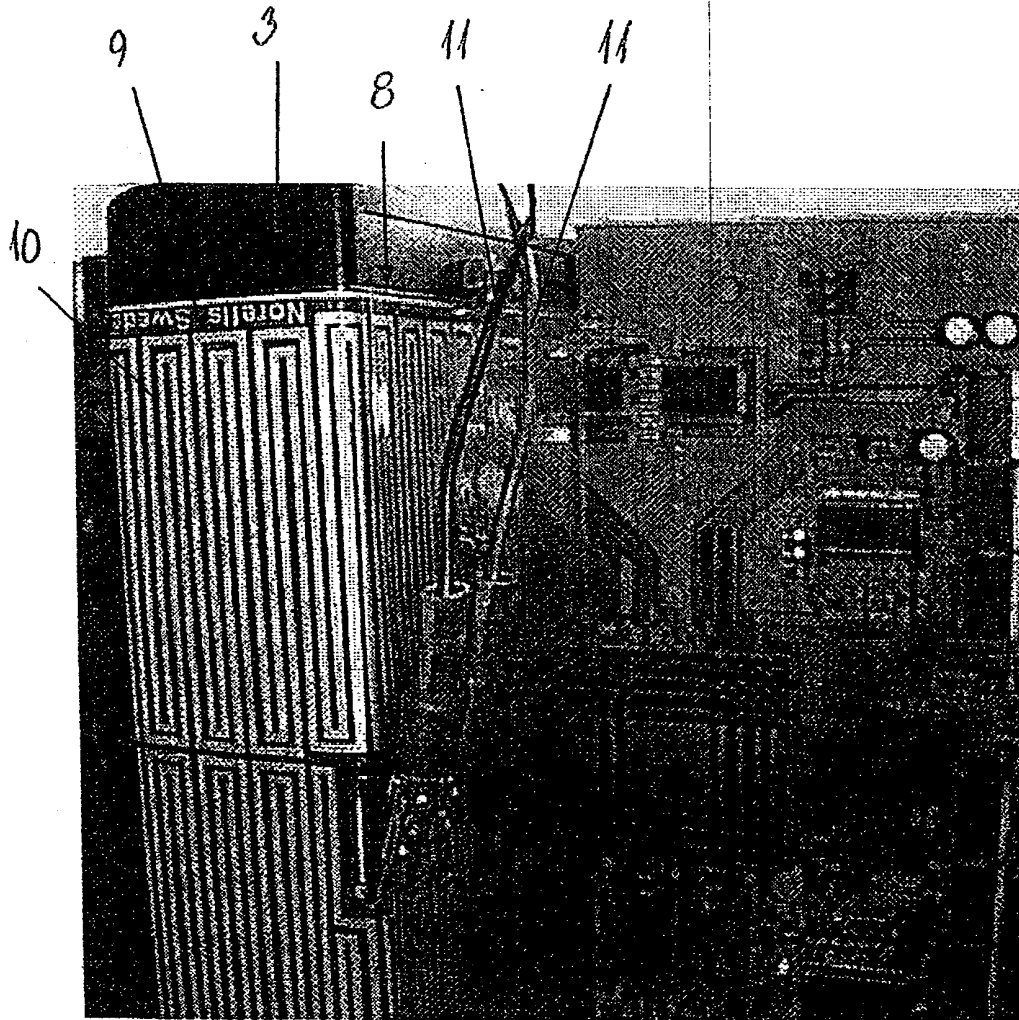


Fig. 3

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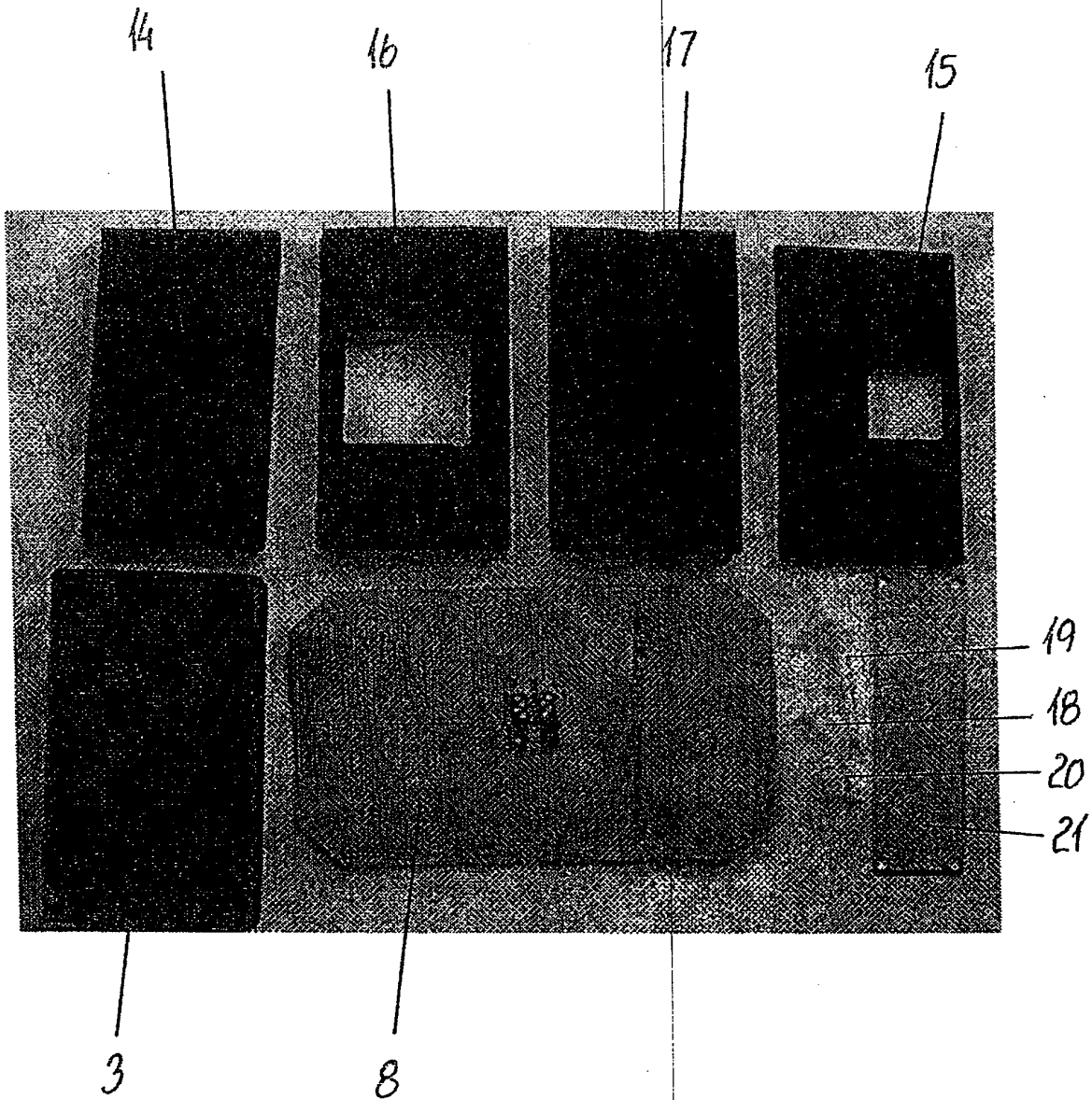
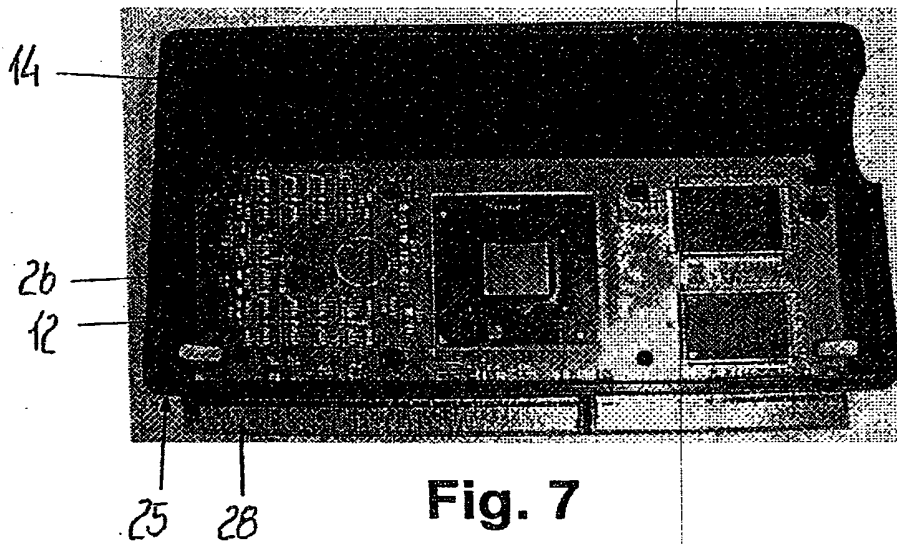
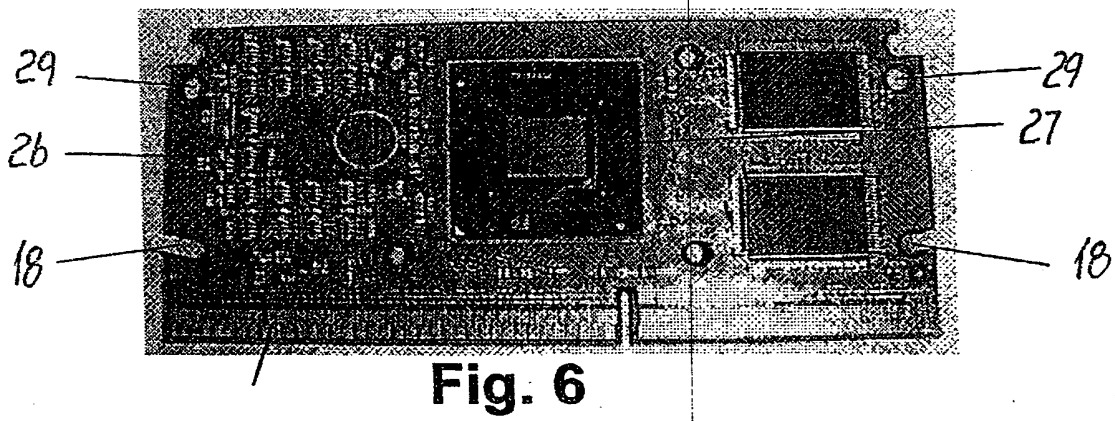
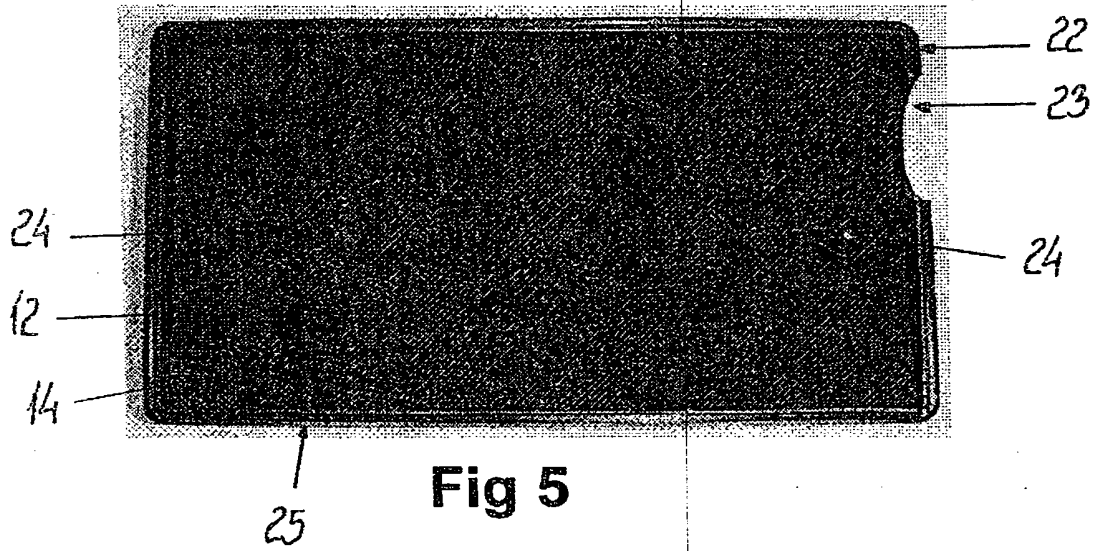


Fig. 4

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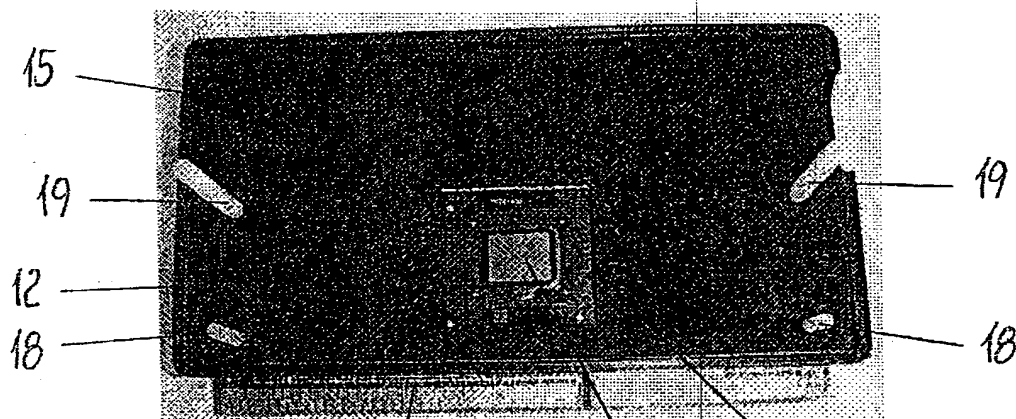


Fig. 8

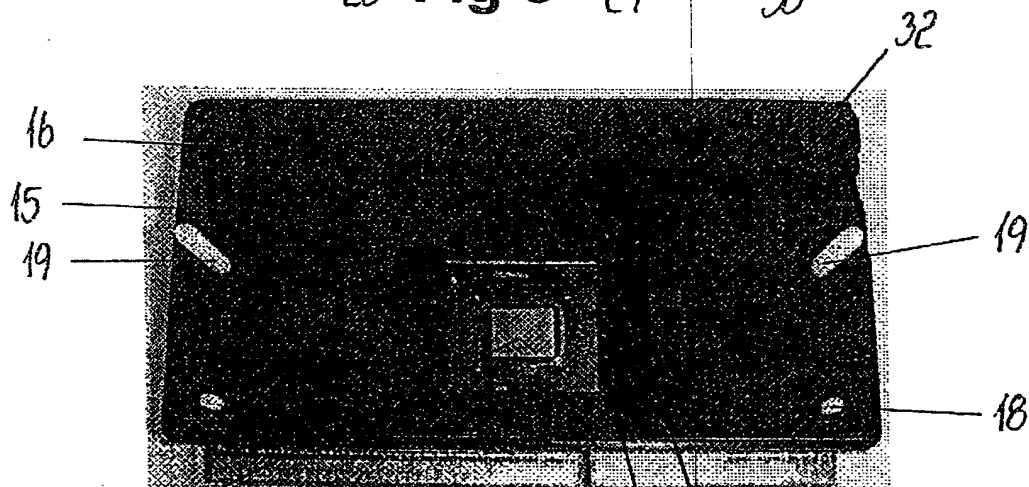


Fig. 9

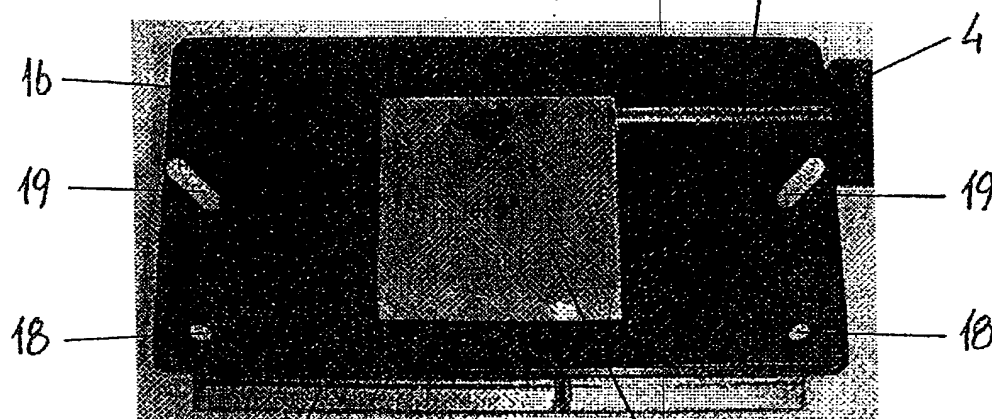
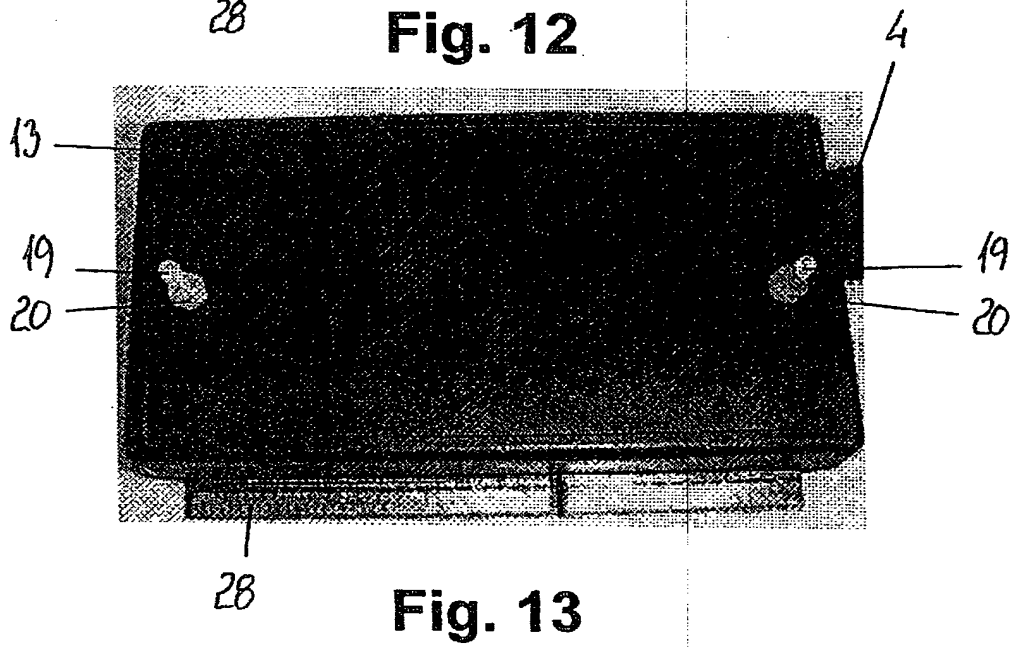
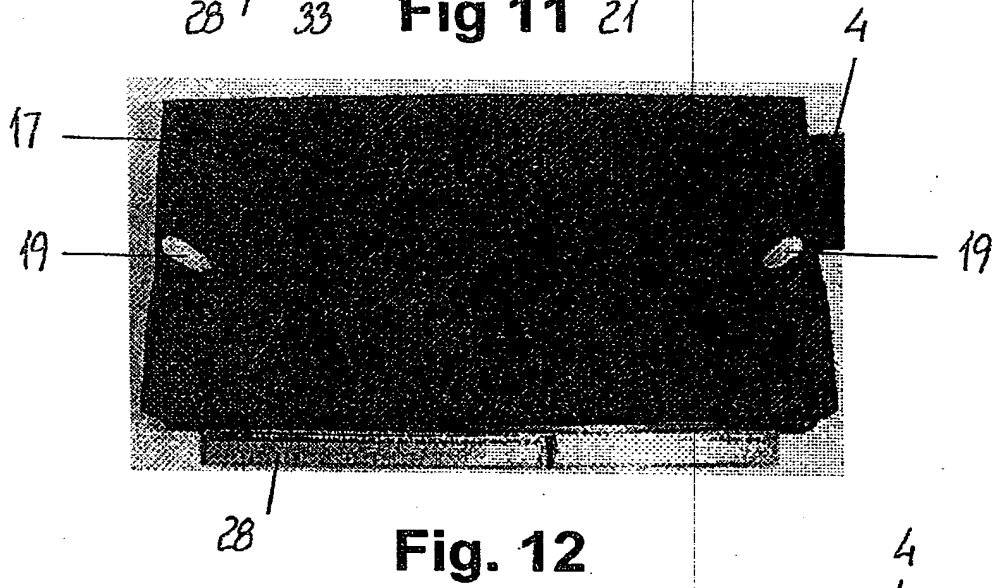
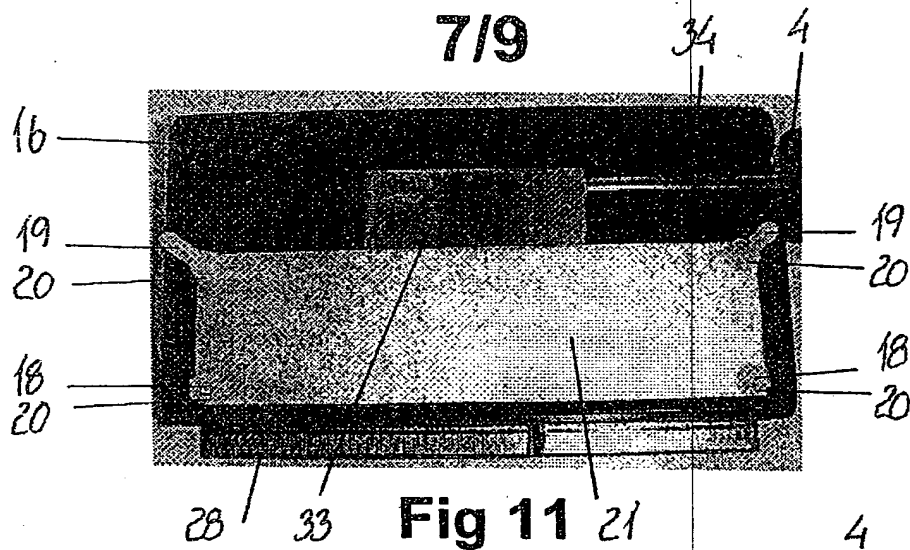


Fig. 10

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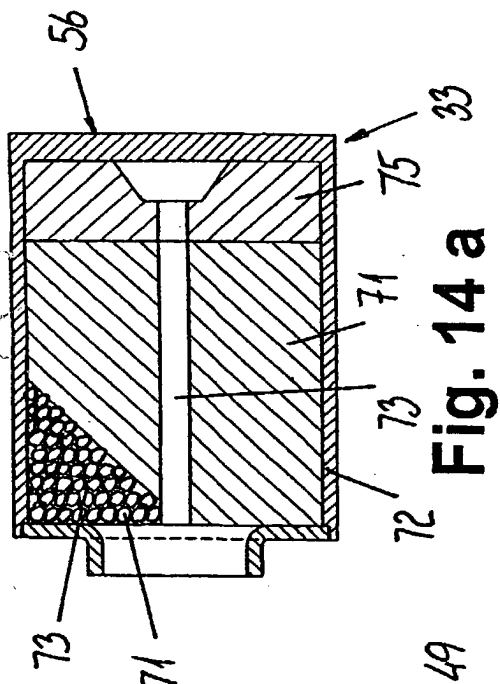


Fig. 14 a

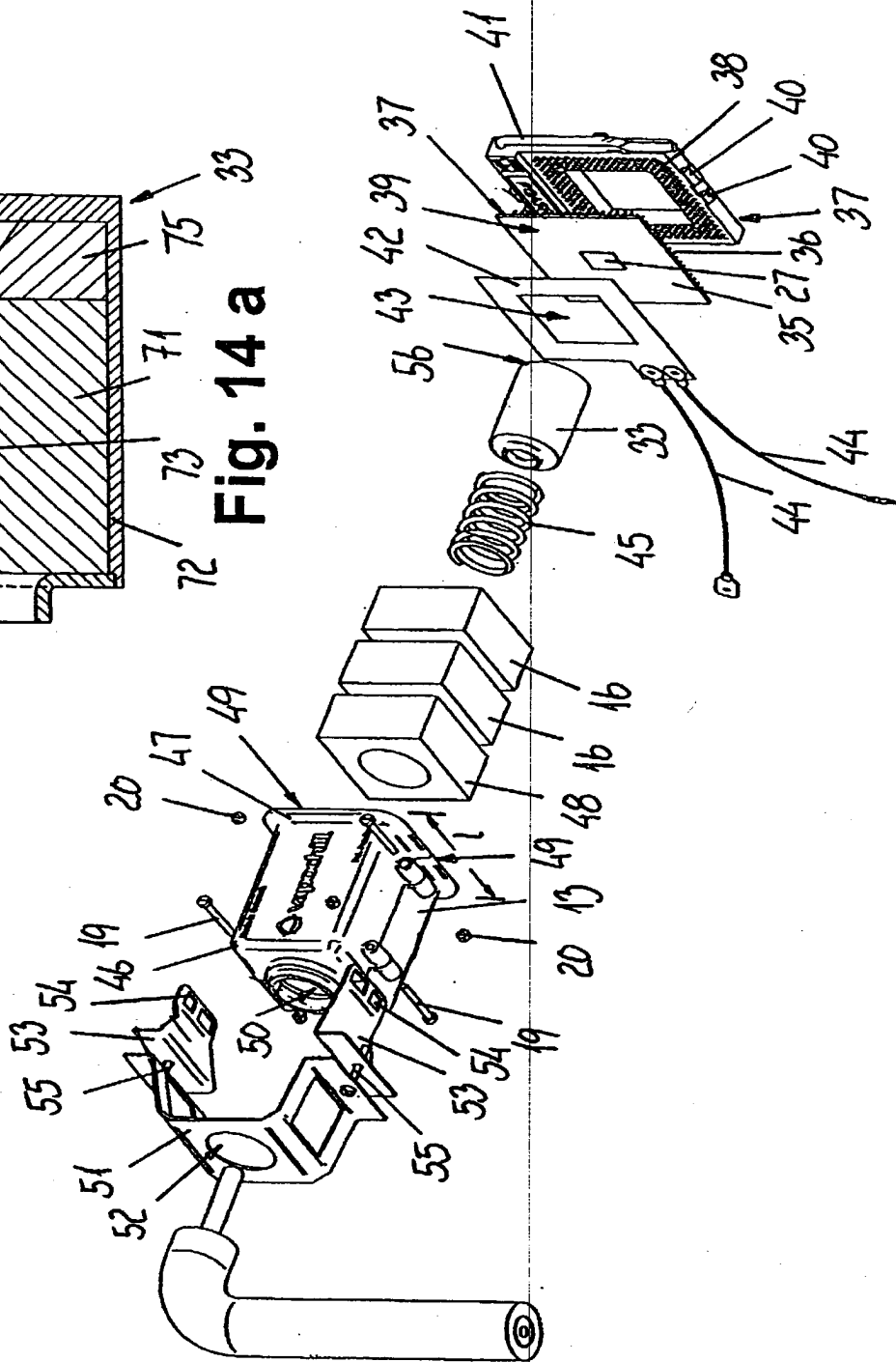


Fig. 14

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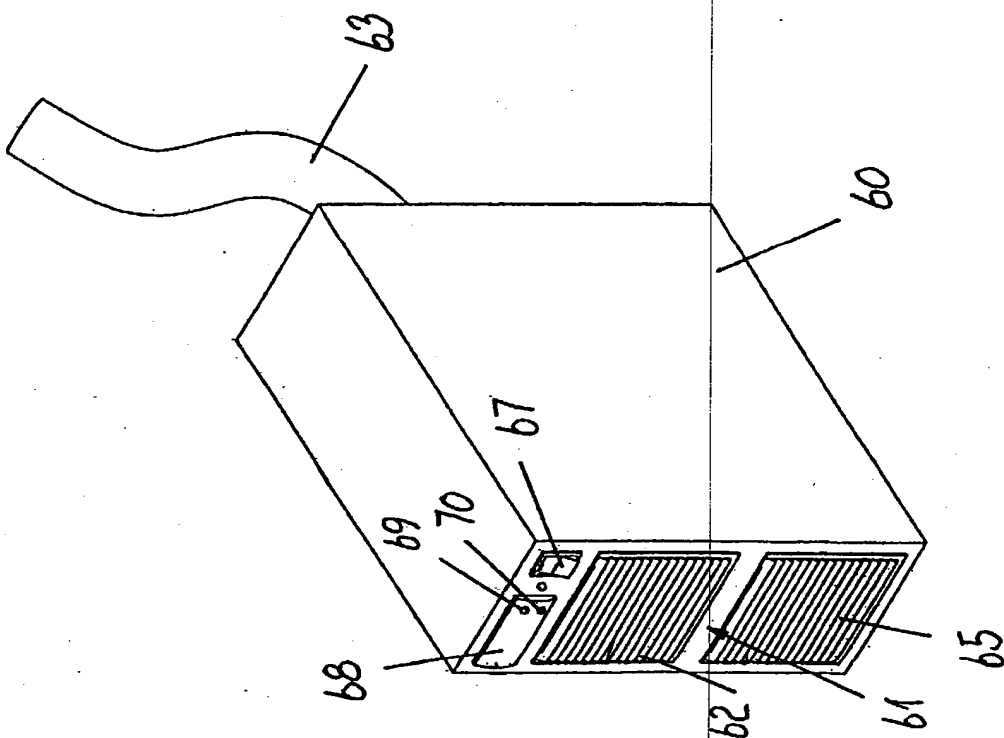


Fig. 15

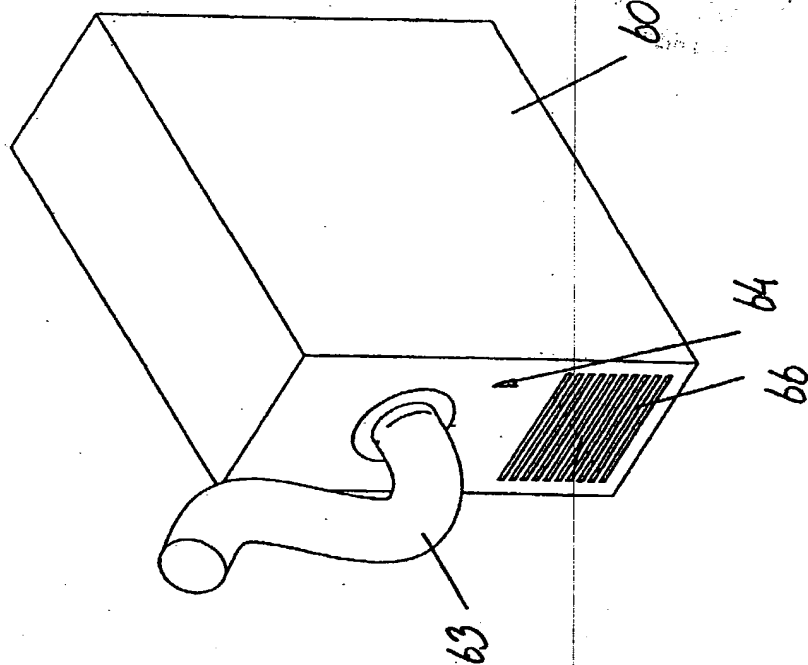


Fig. 16

DECLARATION AND POWER OF ATTORNEY

Atty. Dkt. No.: 45900-000728/US

DECLARATION

As a below named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

COMPUTER SYSTEM COMPRISING A COOLING SYSTEM

the specification of which (check one)

- ☐ is attached hereto.
or
☒ was filed on April 3, 2002 as Application Serial No. or PCT International Application No. PCT/DK00/00554 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. §§ 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)				
APPN. SERIAL NO.	COUNTRY	DATE FILED (MM/DD/YYYY)	PRIORITY CLAIM	
			Yes	No
PA 1999 01416	Denmark	10/04/1999	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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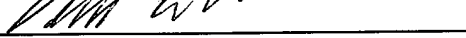
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Full name of sole or first inventor: André ERIKSEN

100 Inventor's signature: 


Date: 06/08/02

Residence: Nørresundby, Denmark DKX

Citizenship: Denmark

Mailing Address: Vestergade 11,2., DK-9400 Nørresundby, Denmark

Full name of second joint inventor, if any: Per ADAMSEN

200 Inventor's signature: 

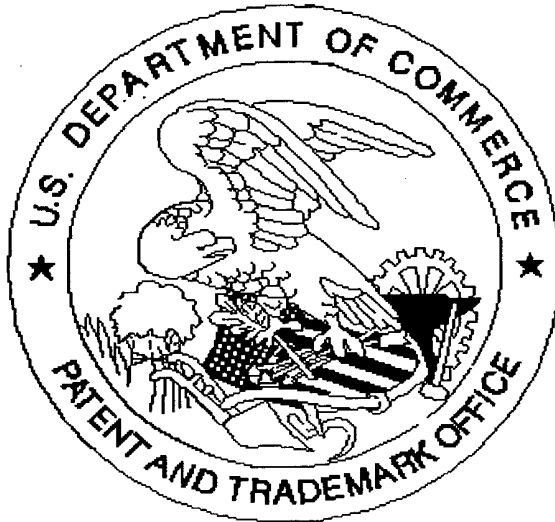
Date: 7/5 - 2002

Residence: Aalborg, Denmark DKX

Citizenship: Denmark

Mailing Address: Kayerødsgade 29, 3., DK-9000 Aalborg, Denmark

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